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Devitrification

Some Reflections on the Recent Work of Morey and of Dietzel

By F. W. PRESTON

IN the May, June, July and August (1930) issues of THE GLASS INDUSTRY, we printed an English translation in full of Dietzel's work on the devitrification rates of various soda-lime-silica glasses.

In the October (1930) issue of the *Journal of the American Ceramic Society*, G. W. Morey, the leading American authority on this subject, examines, among other things, the findings of Dietzel and points out that there must be various errors in Dietzel's work.

One of the most important of these is the probability that more often than not, Dietzel was mistaken as to the identity of the crystals formed during devitrification.

Dietzel discovered only two crystal compositions, one of which he calls Cristobalite (SiO_2) and the other Wollastonite or Pseudo-wollastonite ($CaO.\ SiO_2$). From Morey's work it would appear that the Cristobalite should in all cases have been Tridymite, another form of Silica, while more often than not the Wollastonite should have been the 1:3:6 compound ($Na_2O.\ 3CaO.\ 6SiO_2$), which is not merely a different crystal form, but a different chemical compound.

Morey has provided, in Fig. 2 of the article referred to, an equilibrium diagram of the field of soda-lime-silica mixtures whose proportions of the different oxides are in or near the region of those employed by practical glass men. From this diagram it is possible to say with fair assurance how molten glass will behave during cooling. One can tell for instance, how early in the cooling crystals are apt to begin to form; also what those crystals will be.

We can also tell, whether, if we cool the glass slowly, a second sort of crystal is likely to come out at lower temperature and what this new sort of crystal will be, and at what temperature it is likely to appear.

If we wish, we can also tell just what proportion of the glass will turn to crystals at any particular temperature, though this needs a little figuring, and will not attract the average glassmaker as the best way of spending his time.

We cannot tell, however, how rapidly crystals will form at any particular temperature, and it was this that Dietzel set out to discover, and concerning which he endeavored to find practical working rules. For the glassman's ambition, as a rule, is to get as little devitrification as possible.

At furnace temperatures, glass is just a melt—a liquid. At some temperature, probably between 2,000 F. and 1,400 F., in the flow spouts or working chambers, the glass may get cool enough to devitrify. The first crystals to form may be tridymite, wollastonite, or the 1:3:6 compound, according to glass composition; but in any case the first crystals to form during a slow cooling-down from the melt, are called the "primary phase."

At a somewhat lower temperature a second sort of crystal makes its appearance, and this is called the secondary phase. In most cases the secondary phase is precipitated out of the uncrystallized part of the glass, and does not affect the existence of the primary phase. In fact the primary phase in general continues to form alongside the secondary as the temperature falls.

In the technical field, that is, such glasses as we commonly melt in tanks, if the primary phase is wollastonite or tridymite, then there is about a ten to one chance that the secondary phase is the 1:3:6 compound. If on the other hand the 1:3:6 compound is the first or primary phase to appear, the wollastonite will never show up, and tridymite comparatively rarely, and in fact, in practice, the 1:3:6 is apt to be the only sort of crystal that is formed.

Theoretically we ought always to get a secondary phase, and at times we ought to be able to get three sorts of crystals in equilibrium. Again, at a rather low temperature, the tridymite crystals, if any, ought to turn into quartz, another sort of silica. Further, whatever composition of glass we start with in our tank, provided it is a soda-lime-silica glass, we ought to finish up with a mixture of three sorts of crystals: quartz, the 1:3:6 compound, and sodium-disilicate ($Na_2O.\ 2SiO_2$).

However, glass is pretty hard and viscous before this stage is reached and in practice we are likely to meet only a primary phase of crystal, and perhaps a secondary one of comparatively little importance.

Returning now to Dietzel's work; it is apparent that his

high temperature crystals, or primary phase, are of two sorts. He called them cristobalite and wollastonite, and was apparently wrong most of the time as to their identity; but in effect he has distinguished with accuracy between those glasses in which the first crystals are silica, and those in which they are something else. In other words, he has distinguished between glasses lying to the right of the line P Q in Morey's Fig. 2 (here reproduced with additions as our Fig. 1), from those that lie to the left. In only one case is the matter in doubt, viz., in Dietzel's glass No. 15, which lies so close to the boundary that it is touch and go whether tridymite or 1:3:6 comes out first. In fact to all intents and purposes they will come out together as a binary eutectic (mixture of two sorts of crystals) at any temperature from about 970° C. (1,780° F.) to 870° C. (1,600° F.). These figures are taken from Morey's diagrams, and we reproduce here also (as our Fig. 2) Dietzel's diagram of the crystallizing rates of this glass (Fig. 36 of the article in THE GLASS INDUSTRY for June, 1930). From this it will be seen that both sorts of crystals start to form at 970° C., and both form at about the same rate.

In our Fig. 1, we have plotted on Morey's diagram the positions of Dietzel's various glasses. The little circles with numbers against them represent the compositions of the glasses and the numbers assigned to them by Dietzel. Four of these fall outside the limit of Morey's figure 2, but lie obviously in that "field" where the first crystals on cooling will be silica (tridymite).

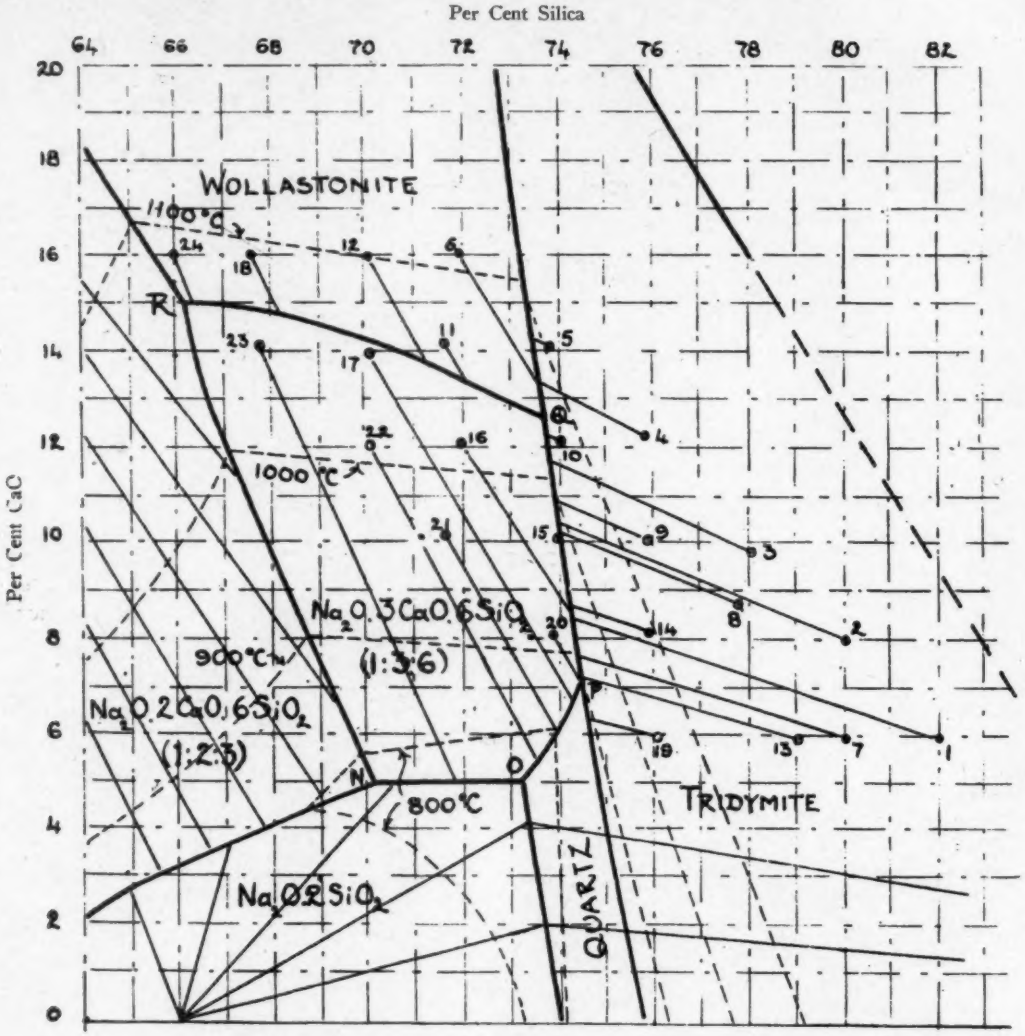

FIG. 1

From the little circles we have drawn straight lines. These lines show how the composition of the remaining glass changes as the first crystal phase separates out. Glass No. 1 for instance, which had originally 82 per cent SiO_2 and 6 per cent CaO, precipitates silica till the composition of the residue has changed to 74.2 per cent SiO_2 8.4 per cent CaO. At this point our lines meet the line QP, and now a mixture of crystals forms, partly tridymite and partly 1:3:6 compound. Dietzel did not find this second phase because the glass would need to have fallen from 1,350° C. (2,450° F.) to 900° C. (1,650° F.) before the first trace of 1:3:6 would appear. By this time the glass would be exceedingly viscous.

Dietzel records crystals of two different chemical compositions only in the case of his glasses 4, 5, 9, 10, 15, 16

and 21. These are the glasses nearest the point Q on Morey's diagram. They are glasses which do not have to deposit much crystal material before the composition of the mother liquor reaches the binary eutectic line PQ, at any point of which the two sorts of crystals will separate together.

Generally speaking, glasses lying near the boundary or binary eutectic line PQ have comparatively little tendency to

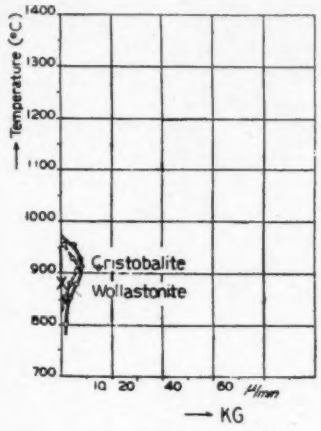

FIG. 2

devitrify, while those lying far off, like 1 or 24, have a maximum tendency to do so.

A glass man who wishes to see, in a rough way, whether his glasses are likely to be good or bad in the way of devitrifying, can do so fairly readily from our diagram Fig. I. For by plotting their compositions on the diagram, he can see how far they are from the point Q, or from the line PQ; the farther off they are, the more tendency to devitrify. The temperature of devitrification can be estimated roughly too, as they extend from the "liquidus" temperature, which is marked on Morey's diagram by contour lines, to a temperature some 150 or 200° C. lower. The "liquidus" temperature is given by Morey in Centigrade degrees and for commercial glasses lies between 800 and 1,100° C. To save the glassman's time we give here the conversion into Fahrenheit degrees.

°C	°F.	°C.	°F.
800	1,390	1,000	1,730
850	1,480	1,050	1,810
900	1,560	1,100	1,900
950	1,650		

And the temperature at which devitrification is apt to take place will be from these temperatures (obtained from the figures) to a temperature some 300° (Fahrenheit) lower.

From the figure one can say, also what sort of crystal will be formed but that does not generally concern the glass man so directly as the size and amount of the crystals.

It must be remembered that the fundamental work of Morey and the practical work of Dietzel are both limited to glasses containing nothing but soda, lime and silica. The presence of comparatively small amounts of magnesia or alumina makes considerable differences. We cannot tell with precision what the addition of either magnesia or alumina will do to any particular glass, but it seems that in most cases, if the amount is small, the tendency is towards preventing devitrification.

In this brief review we are not attempting a strictly scientific discourse, but rather to make a few observations that may enable the glassman to use with advantage the work of Morey and of Dietzel, and may help him apply it to the study of his own glasses.

Index of Refraction Versus Composition of Soda-Lime Glasses[1]

In connection with the Bureau's[2] work on optical glass, it seemed desirable to determine if possible numerical relations between the chemical composition of glasses and their refractive index which would cover a larger field than those previously investigated.

A series of "pure" glasses ranging in composition from about 50 per cent each of silica and soda to 80 per cent silica —20 per cent soda, were made. Also, similar glasses were made in which from 3 to 15 per cent lime was substituted for soda. The raw materials from which these glasses were made were selected with the greatest care; the soda and lime were chemically pure and the silica was obtained from large colorless quartz crystals. The glasses were melted in a platinum crucible, heated in a platinum resistance furnace.

The refractive indices (N_d) of these glasses were measured by an immersion method which gives an accuracy of approximately 0.0003. All of the glasses were carefully analyzed, in some cases the percentage of soda being obtained "by difference."

A study of the data led to the conclusion that the index of refraction of soda-silica and soda-lime-silica glasses in the range between the ordinary commercial glasses and the exceedingly soft glasses can be computed from the following equations in which P is the percentage of the respective constituents:

N_d due to SiO_2=0.042712 (P) 0.79487—0.2,
N_d due to Na_2O=0.0153 (P)—0.00837,
N_d due to CaO=0.017219 (P)—0.00103.

Using the above expressions, the index of refraction of 33 of the 35 experimental glasses can be computed to better than 0.001 and in the majority of cases to about 0.0005.

[1]Journal of the Franklin Institute, Apr., 1930, p. 553.
[2]U. S. Bureau of Standards Notes.

High Heat Resisted by New Compound

According to tests reported in the *New York Times*, a floor, half of which was constructed of a new heat resisting compound 4½ inches thick and the other half 10½ inches thick, with a half inch Portland cement finish was loaded to 150 pounds to the square inch. The temperature of a furnace directly under the flooring was kept above 1700° for more than four hours, at one time reaching 1910°. At the end of the fourth hour the hottest surface temperature recorded on the thicker half of the floor marked an increase of 11°.

"The Log of the Lab," published by the Forest Products Laboratory, U. S. Department of Agriculture, Madison, Wis., mentions that the laboratory is again offering a 6-day course of instruction and demonstration in economic and efficient boxing and crating practice and transportation hazards of car movements, the first course of its kind to be given by the Laboratory since the Spring of 1929. It will be conducted by the container research staff, January 12-17, 1931, inclusive. Inquiries should be addressed to the Director, Forest Products Laboratory, Madison, Wis.

Russian Industrialization

By R. M. KING[1]

IN view of the great interest manifested by the Pittsburgh district branch of the American Ceramic Society in Professor King's comments on Russia during his lecture on his recent tour of Europe, we have asked him to amplify his remarks for inclusion in this issue of The GLASS INDUSTRY. A fair understanding of the Russian situation is the more important, since Russian interests have been advertising in our pages for glass experts to go to Russia.

We, therefore, feel that we are doing a service in publishing this account for our readers, but it must be understood that, although Professor King's report is based on personal experience during a recent tour, we accept no responsibility for the Soviet Government.

Only in this last week, we have received personal advices from gentlemen in Norway and Poland, engineers with twenty years of experience in Russia under all regimes, including short stays there during the last few months, that on no account should their relatives, though speaking Russian and well acquainted with the country, sign up any contracts to go to Russia.

The depreciation and watering of the Russian currency, combined with artificial methods of trying to stabilize it at the frontier, are not encouraging signs; I have seen the same fiasco in Portuguese Africa.

We hold no brief for the present capitalistic system in America; it is not equal to modern requirements and is inherently unstable. We do not, however, on that account feel any enthusiasm for the artificial communism of Russia. With this understanding we are very glad to present Professor King's findings to our readers.—F. W. P.

PROF. R. M. KING

THE greatest peace time engineering project of history is the present industrialization program in Russia. They are literally lifting a nation of 150,000,000 people, occupying one-sixth the landed area of the globe, and possessing at least one-fourth the natural resources of the earth, from medieval servitude and ignorance to the plane of modern industrialism and high standards of living. Even a short stay in Russia impresses one with the comprehensiveness of this program, with the efficiency with which it is being carried out and with the cooperative attitude displayed by the Russian people. One is reminded of the Liberty Loan drives during the war when everyone was "high-pressured" into giving, saving and working. The museums, theaters, parks and other public places are beehives of propaganda. Electrically lighted charts and graphs show locations of big industrial projects and the progress being made. One would think that the country was full of high powered American press agents and efficiency engineers. In fact this is true to a large extent. I was unofficially told that the Soviet Government expected 5,000 American engineers to be in Russia at the end of the past summer, and they are still going. We found these Americans doing everything from installing incubators and making watches to building huge power plants.

[1]Assistant professor Ceramic Engineering Ohio State University.

The basis of this great program is what is known as the Five Year Plan. It calls for the expenditure of $30,000,000,000 to $40,000,000,000 during the five year period, beginning October, 1928, and ending October, 1933. The plan consists of a carefully arranged budget for spending the money necessary to carry out predetermined schedules for the industrial and agricultural rehabilitation and modernization of the entire country. However, as comprehensive as this scheme is, it is only a beginning of what must be done for complete rehabilitation.

The question arises in the minds of many as to where the money is coming from. Because of confiscation of private property and repudiation of foreign debts, the credit of Russia does not rank very high among her sister nations. However, they have been advanced loans and credits by some of the European nations and by private interests in the United States. They also float large internal loans. A quotation from an address of Mr. Harold Kellock before the Williamstown Institute of Politics last summer is interesting in this connection. "How are huge expenditures for capital construction involved in this Five Year Plan provided? They are, so to speak, literally squeezed and sweated out of the economic machine. Every cent of profit from the great state industry is relentlessly plowed under, not necessarily in the industries which produce the profit, for the easy money industries are required to carry economically justified but as yet unprofitable ones. Every device for economy, for labor saving, for doing away with lost motion is studied and applied within the limits of a country where the average man is not accustomed to efficiency. Taxes are everywhere in evidence. The traveler meets them on his hotel bill and on each one of the many official papers he must procure. There are excise taxes on many articles such as textiles, matches, salt, tobacco and beverages. Common foodstuffs, including bread and meat, are commonly rationed to avoid excess waste. In the large cities, living quarters are severely restricted. Personal luxuries are very scarce and expensive. Large internal loans are floated with all the poster and publicity propaganda of war loans. In this process of trying to "beat" the Plan, every inch is hailed by the press and at public meetings; and remote Siberian villages get a thrill out of it over the radio. The Five Year Plan has become a real national game in which all the citizens feel themselves participants. A recent issue of a Russian newspaper carried the following story: "Sixty-one tractors are going to waste. Sixty-one tractors are uselessly moving along our northern meadows and fields. These sixty-one tractors have not plowed a single acre nor carted a single log. Who has permitted such an outrage?" Where were the tractors? They were in the horses' tails. There were nearly 400,000 horses in the region, each with 100 grams of superfluous hair in his tail and the price of horsehair was 2.30 rubles ($1.17) per kilogram in Berlin. "We will clip these tails like coupons of bonds," said this northern Slavic go-getter, outlining his hair cutting campaign. "Let the capitalists give us tractors in

payment for these coupons." That advertisement involves only a small article, but it gives a glimpse of some of the ingenious ways in which money is raised.

"In figures nearly 40 per cent of the new capital comes from the profits of the industry, over 30 per cent from taxes and nearly 15 per cent from internal loans."

It may happen that Russia's bad credit will turn out to be a blessing rather than a calamity. The lack of outside credit will cause her to turn to her own resources and we may find that she will emerge from her troubles with industry, agriculture and government on a sound basis and with a minimum of external debt.

Capitalistic nations will observe that in this communistic state the government receives the profits and reinvests them in the industries that need them. All is profit but the actual expenditure for labor and materials from without. In a capitalistic country, the part of the profits known as taxes is all that the state gets, the remainder is controlled by the specific industry that makes the profit, and if reinvested, the greater part of it at least is invested in that industry. Of course some of it sooner or later, either directly or indirectly, finds its way into other industries through the buying of securities.

Now for some of the specific projects of this famous plan. A great super-power system is being built up in South Ukraine on the Dnieper River. A large dam and hydroelectric plant are being built, to cost a total of $110,000,000. The dam will have a masonry cubiture greater than the Assuan Dam in Egypt or the Wilson Dam in the United States. The hydroelectric station will be the center of a vast super-power system for existing and future industries within a radius of 275 miles. The item of power in the production budget of the Plan provides for a total possible output of 22,000,000,000 kilowatt hours in 1933; 331 per cent more than in 1928 and eleven times the production of 1913. This huge program will necessitate capital investments in public utility power plants, not counting those connected with industrial establishments, of $2,302,000,000.

The production of farm crops is scheduled to increase 58 per cent in physical volume. Farming in Russia has been, and to a large extent is now, of the hoe and scythe type. Peasants formerly owned on the average of ten or twelve acres of land. It was difficult to afford expensive farm machinery from the income from so little, and it would have been difficult to use it efficiently if it could have been afforded. Hence the idea and apparent necessity of large scale farming, which is called Collective farming. The government furnishes the land and machinery and the peasants pay a rent to the government for land and machinery. The Soviet Government is planning to cultivate 300,000,000 acres on the collectivation scheme. This land was until recently worked by 25,000,000 peasants.

The output of tractors is expected to increase to 55,000 and automobiles to 130,000 in 1933, many times the production of 1928.

Transportation, educational, social and cultural needs are not being overlooked for these are also carried in the budget.

For the manufacture of ceramic products the budget calls for the following capital investments:

Cement	$52,000,000
Fireproof materials	13,000,000
Brick	31,000,000
Lime	8,000,000
Scientific and other institutes	8,000,000
Glass	13,000,000
Scientific technical administration	17,000,000
China and porcelain	3,000,000

This is truly an ambitious scheme. While one hears and reads about the accomplishment of various included schedules, it is not likely that the plan will be entirely accomplished in the time allotted. A man prominently identified with a large American corporation who spent some time in Russia last summer, stated that even in our own country such a plan could not be accomplished in five years. A prominent Russian official, in a newspaper interview in Paris in September, stated that the entire plan would not be accomplished in five years, but progress is being made. Other reports state that, in quantity, accomplishment is close to schedule but quality is lower and cost of production higher than expected.

Mention has been made of the prominent part Americans are playing in this work. It is quite probable that the role of the commercial representatives in Russia and the representatives of Russia who are in America to study our methods will be the chief factor in bringing about an official recognition of the Soviet by the American government. There is no doubt, however, that this reciprocal association will modify the American attitude toward communism and the Russian attitude toward capitalism.

Parsons List of Optical Glasses

We have received from the Parsons Optical Glass Co. of Derby, England, a list of their optical glasses for scientific work. Some seventy glasses are described, the optical properties listed including the refractive index for the yellow helium line and the dispersion and partial dispersions.

Until comparatively recently it was customary to use only the sodium yellow and the hydrogen red and blue, and perhaps the hydrogen violet line, in specifying the optical properties. In the present catalogue the helium yellow replaces the sodium for most purposes, and a more complete range of dispersive values is obtained by adding the helium deep red (b line) and the mercury green, blue, and violet to the three hydrogen lines.

The helium yellow (5875) is quite close to the old sodium doublet 5893, and is more convenient with modern technique. The addition of the mercury lines and the helium red at 7065 will be of advantage to the designer who needs an exceptional degree of achromatism.

The Parsons Optical Glass Co., formerly the Derby Crown Glass Co., with which Dr. C. J. Peddle's name is associated in our memories, always proved strangely successful in the making of dense barium crowns, one of the most awkward of optical glasses to be found. We note that the recent price list of the company shows that in this category, where no less than 17 varieties are listed, there has been a substantial reduction in the price of sixteen of them.

We congratulate the company on its enterprise.

The Manufacture of Rolled Plate

By ERNST LUTZ *

(Continued from the December, 1930, issue)

This work has been revised, so far as the English and the technical expressions are concerned, by F. W. Preston, who has also added a number of notes relating in general to the special conditions of American practice; but it must be understood that the opinions expressed in the text are those of Mr. Lutz, and neither the Editor nor Dr. Preston accepts responsibility for them.

Figs. 43 to 48 show a machine of this type (as described in the December, 1930, issue) for which the German patent No. 246126 of the 13th of September, 1910, was granted to the Société Anonyme des Glaces de Saint Marie d'Oignies of Aiseau, Belgium, this was designated and constructed by the engineering firm of Zimmermann, Haurez & Co., of Monceau sur Sambre. The two tong shanks a and b (Fig. 48) can be moved symmetrically about the longitudinal axis of the tongs around the two bolts d and e, and are otherwise carried by the structural steel frame c. On this frame are also the two stands P and Q for the two operators. At P the four starters for the electric motors are at hand. which serve for the movement of the crane proper f, the cross movement of the trolley g, the turning of the platform h and the lifting and lowering of the frame i, which also is built up of structural steel and carries the frame c with tongs and the operators' stands P and Q.

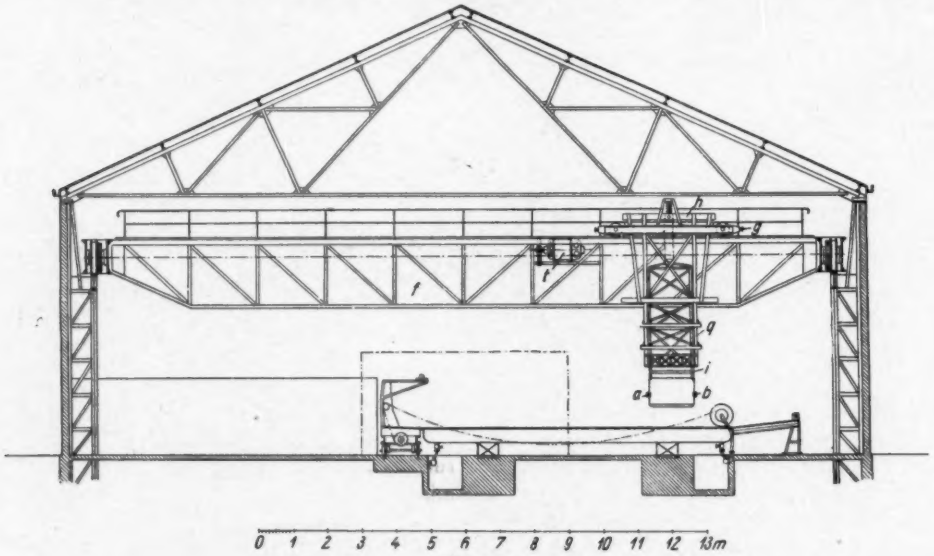

FIG. 43

From Q are served the handwheel k for the opening and closing of the tongs, the handwheel l for the severing of the pot from the furnace bottom, and finally the handwheel m for turning the tongs round their longitudinal axis, when pouring out the glass.

The frame i is suspended on two calibrated chains running over the chain wheels n, which, through two worm gears, are driven from the common motor o. The frame i is fitted with bars p, gliding in four guides q of channel-section, which are rigidly fixed to the turning platform h. In turning this platform h, the said guide arrangement also turns the chains and the whole of the vertically movable part of the frame i, including the tong. This turning is effected by the motor r, which, with the aid of a worm, drives a vertically placed pinion engaging with a cast steel gear wheel of the trolley g. The upper surface of this gear wheel serves at the same time as rail for the six wheels of the turning platform. The inner, smooth surface of this cast steel gear wheel is further the bearing surface of four rollers centering the turning platform. The motor s handles the cross movement of the trolley, whilst the motor t is used for the movement of the crane bridge proper.

The lowermost frame c is fixed to the sliding frame i by means of a hinge u, tie-rods v, levers w and the shaft x. The inclination of the frame c, and the tongs, in the hinge u, is necessary, as the furnace bottom is sloped like a roof. (*See Vol. I, table VII, Fig. 2 of Dralle-Keppeler, Die Glasfabrikation.*) The pot is therefore not exactly in a horizontal position in the furnace and the tongs must be adaptable accordingly. For casting, on the other hand, both tongs and pot must be set horizontally. The swinging of the frame c, round the hinge u is done with the handwheel l, which turns a worm y, engaging with toothed segment. This segment is rigidly fixed to the frame i. The casing of the worm has

*Of Desseau, Germany. This work will appear in German in the forthcoming new edition of *Dralle-Keppeler*, "Die Glasfabrikation," due next year, about July. The GLASS INDUSTRY probably will by that time have completed the English translation, with some comments on its applicability to American conditions by F. W. Preston.

FOOTNOTE: In the Figures, originally prepared for use eventually in the coming new edition in the German language of *Dralle-Keppeler*, "Die Glasfabrikation" in 1931, dimensions are given in metres (m) and millimetres (mm). We would like to have given these in feet and inches but the translation and the making of nearly two hundred and fifty new illustrations would have involved a prohibitive loss of time and expense. To some of our readers the metric system is as familiar as the English units; for the others we may say that a metre is approximately 40 inches, and a millimetre is approximately 1/25 of an inch. A thousand millimetres, of course, go to a metre. —*F. W. P.*

two arms A keyed on the shaft x; evidently, if the worm moves upwards on the segment, the shaft x is turned and with it the two small levers w are lifted upwards, taking the frame c with them by means of the toe-rods v. If, on the other hand, the worm y moves downwards on the segment, the frame c is swung downwards round the hinge u. The device just described is also used to break the pot from the

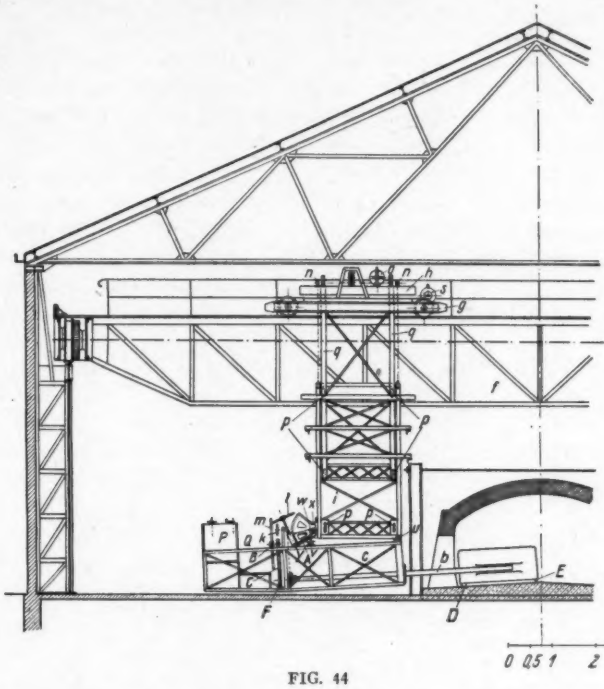

FIG. 44

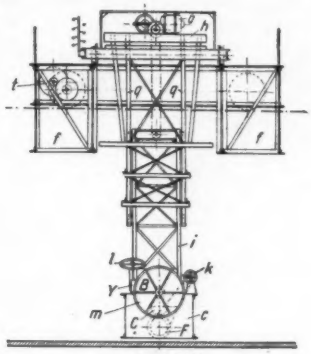

FIG. 45

furnace bottom; when the tong shanks have gripped the pot the frame c is turned upwards with the handwheel l so that the pot starts at the point D to leave the furnace bottom, as a force is exerted on it which tries to tip it over the point E. It would take much more force if the motor had to lift the pot as a whole; further the tong shanks would be heavily stressed and the pot belt damaged by the high tension applied.

The turning of the tongs on their longitudinal axis, i.e., the turning of the pot for pouring, is so managed, that the handwheel n with the pinion B and the idler C acts on the gear wheel F. The gear wheel F is keyed on the end of the central bar G of the tongs. The turning bolts d and e of the two tong shanks are journalled in a ring H of a ball bearing I which is fitted in a cast steel plate, forming the front wall of the frame c. Through this ring H the middle bar of rectangular section passes snugly, so that if the bar is turned by the gear wheel F, the ring H is taken with it and through the interconnection of the two bolts d and e, also the tong shanks, thereby tipping the pot. At its rear end the middle bar G runs in the ball bearing K. The turning of the tongs is so easy, that a pressure of the hand on one of the shanks, for example, readily starts the movement.

The opening and closing of the tongs with the handwheel k uses a small chain drive to a pair of bevel wheels; one of these two bevel wheels is made in one piece with the chain wheel and is loose on a cylindrical section of the middle bar G, the other bevel wheel is keyed on a spindle, on which a right and left handed screw is cut. The spindle, in its middle, is carried by the bar G and on its two screwed ends has two nuts, which sit in the ends of the tong shanks a and b. It is evident that if the spindle is turned, the two nuts move to and fro, and with them the ends of the tong shanks so that the tong is opened or closed. At its front end the middle bar carries an elastically fitted extension, serving as stop towards the pots. For the starting of the trolley a motor of 15 to 20 hp. is required which brings it to a speed of about 250 feet per minute. The motors for lifting and turning both are only about 6 to 7 hp. so that the frame i can be moved with about 4½ feet per minute up and down and the turning platform make about 2 to 2½ turns per minute.

The motor of the travelling crane is of such size, that after running up, the crane can travel at a speed of 250 feet per minute.

Now the casting table may stand crosswise to the path

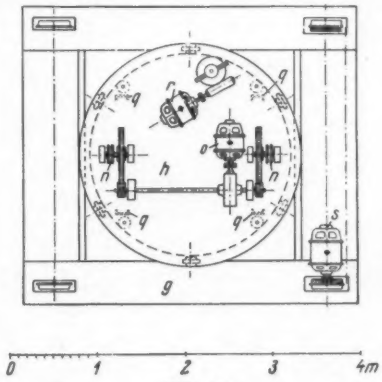

FIG. 46

of the travelling crane, as for example in Fig. 43, or lengthwise; in the former case the whole bridge-crane has to be moved crosswise to the casting table for the purpose of pouring out and distributing the heap of glass over the whole width of the table. In the latter case, the crane-bridge can remain at rest and only the trolley with the suspended frame

(i) need be moved across the table. The motor of the travelling crane has to be sufficiently powerful to ensure a quick starting of the heavy crane-bridge even in the first mentioned case. Depending on the span of the bridge, a 30 to 35 HP motor is about right. This size of motor is also

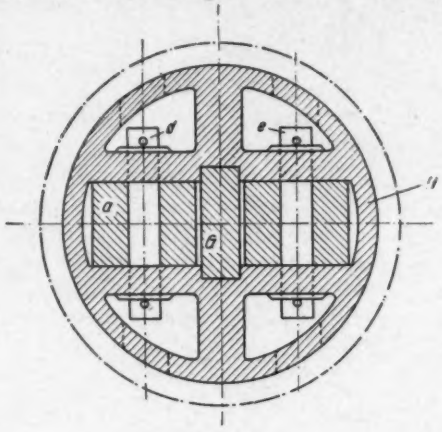

FIG. 47

of the row of furnaces and if more than two or three furnaces are in commission so that long distances have to be covered. This is particularly so, when the furnaces farthest away from the casting table are alone in commission; the casting under such circumstances is undesirably delayed. By choosing a stronger crane motor, it is possible to raise the crane speed to 330 feet per minute and thus at the outset manage to handle three or four furnaces. On account of possible derailing and high stresses set up in its framework in starting and stopping, a still higher speed is however not advisable for these heavy crane-bridges. The rough glass factory has either to be so set out, that part of the furnaces stand on one side of the casting table and the rest on the other side of it, so that the crane has not to pass along the full furnace row, or else that two cranes I and II can be in commission (Figs. 49 and 50), or two cranes running in parallel bays have to be provided, see Fig. 51 and 52.

This last mentioned arrangement, however, is only practicable, if the casting table is erected in the continuation of the furnace row in the shop centre and lengthwise of it, so that when casting, the trolleys of the two cranes may move

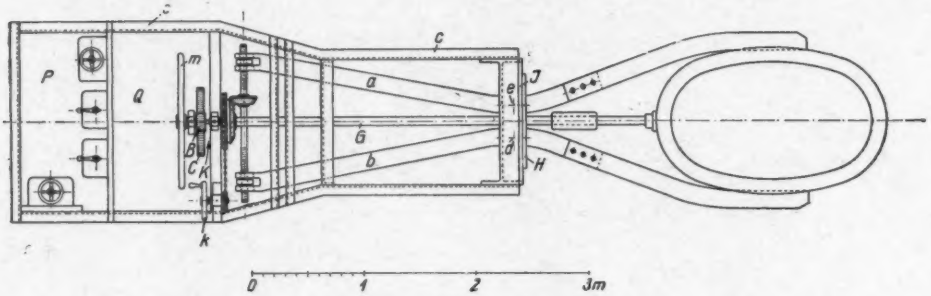

FIG. 48

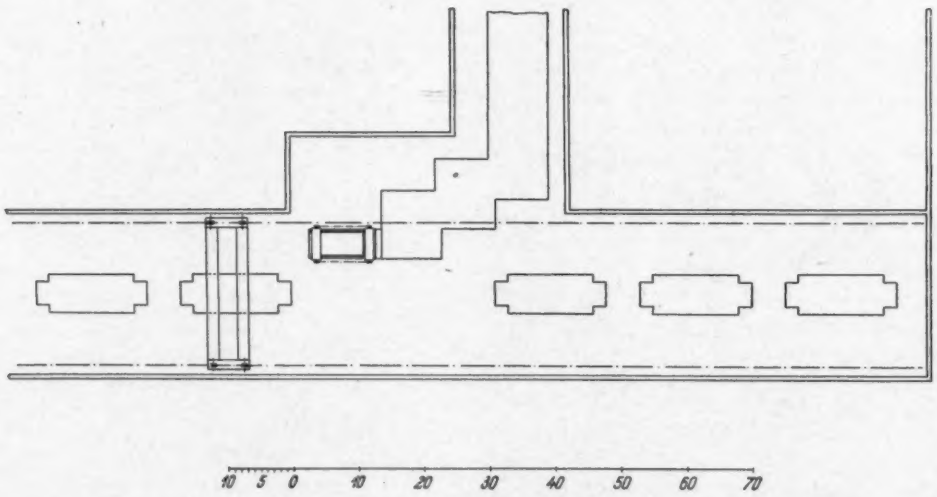

FIG. 49

capable of running the crane at a speed of 250 feet per minute. In smaller rough glass factories, with not more than two furnaces in commission, the said crane speed is thought satisfactory.

However, with one crane only, and of course depending on the craftsmanship of the crane operator, this travelling speed will be too low if the casting table stands at the end crosswise to the casting table. An opposite arrangement is not feasible, as with the usual continous lehr, the two cranes could not cover the end of the casting table adjacent to the lehr. A way out is a design as shown in Fig. 53, where one crane overlaps the other, this means, however, an extra heavy roof and crane-bridge construction. Or again two casting tables, as shown in Fig. 54, would be required. In

this case the travelling crane I would pour on table 1 and crane II on table 2. The sheets rolled on table 1 would have to be conveyed over the table 2 to the lehr. The roll winch would evidently have to be so designed, that the roll after leaving the table 1 could cross table 2 at an appreciably higher speed and reach the winch in time to permit a prompt start with the insertion of the sheet on table 1 into the lehr. Although this arrangement is practicable, it is only resorted to under great pressure of circumstances, as with it the danger of cold cracks* and fissures in the sheets, which have to be drawn over such a length from the table 1 to the lehr is increased.

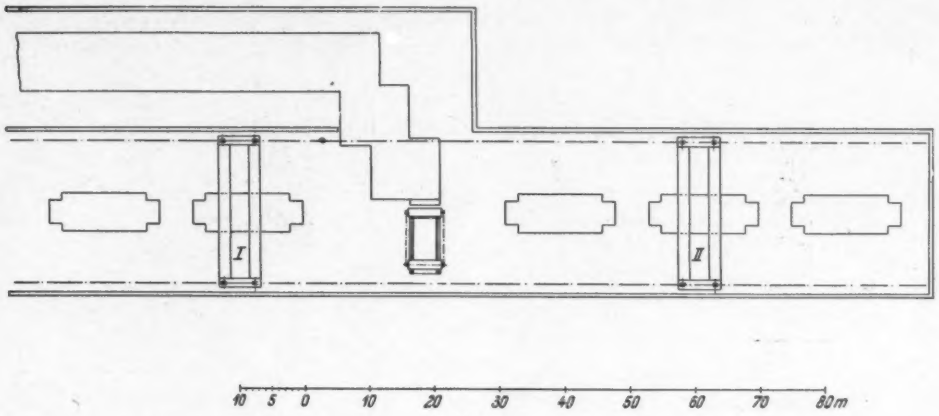

FIG. 50

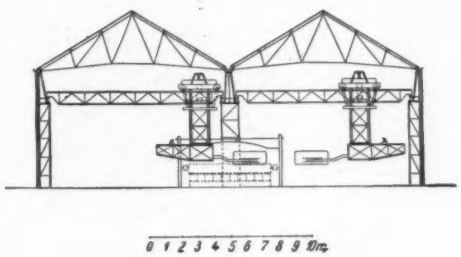

FIG. 51

In the layout of a rough glass factory, and in the arrangement of the furnaces, the casting table and the lehr, the choice of one or more of such travelling cranes for the removal and the pouring out of the pots is of paramount importance. If prevailing circumstances, such as the site itself or existing rail connection or already existing polishing shop, etc., do not leave a free hand, then the adoption and incorporation of such travelling cranes is often not possible; it may happen that one is forced to provide a crane for the handling of the pots only, i.e. for inserting and withdrawing them and that a separate crane is required for the casting. However, such an arrangement is only justified if

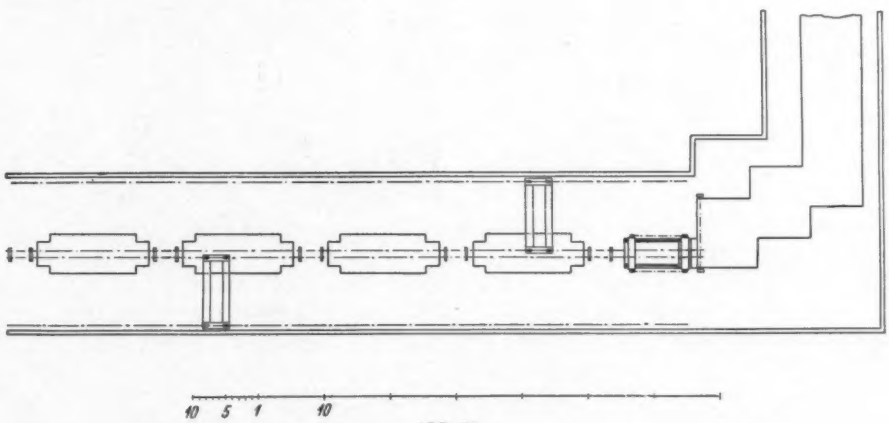

FIG. 52

tong carts as illustrated in Figs. 40 and 41 are not in use, as these imply an absolutely clear and free path between the furnace ready for casting and the place where the pots are set down to be taken charge of by the casting crane. If several furnaces, standing in a row, are in commission and the casting table is located at one end of them, as for example in Fig. 2, one is forced to finish first the furnace farthest away from the casting table, then the last but one, and so on, until the furnace nearest the casting table is reached. With a different succession of furnaces, those finished with the casting could not be recharged with pots and batch material, since the tong carts frequently pass them. It can happen, however that, in the process of melting and refining, a furnace may be so delayed that the casting of the next furnace must be started with. Due regard must be

*Generally known as chills or "checks."—*F. W. P.*

given to this possibility in districts where it is difficult to keep a supply of good workmen. Of course bridge-cranes can avoid obstacles. With reliable workmen at hand it can be assumed that in quite exceptional cases only will there occur a break in the regular succession of furnaces for casting. Thus if there is no crane for handling the pots or

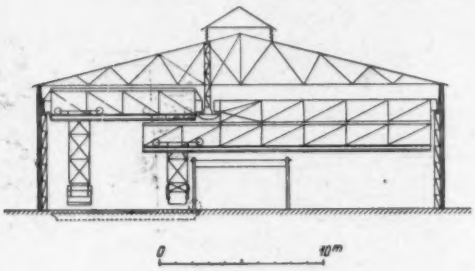

FIG. 53

even for the casting on the table, cranes as in Fig. 35, 36 and 37 but perfected as in the U. S. A. or tong trucks as in Figs. 40 and 41 will be preferred.

These tong trucks work appreciably faster than cranes; not only can they travel as fast, but above all the insertion and withdrawal of the pots at the furnace proceeds much faster than with cranes, especially those in Figs. 43 to 48.

If once the tong truck is set in the direction of the longitudinal axis of the pots, its traverse table G (Figs. 40 and 41) inclusive of the tong can be moved forwards, grip and lift the pot and be drawn back again in one operation. The crane on the other hand can move its trolley g (Fig. 55) only at a right angle to the furnace. Thus if the tongs are set in the longitudinal direction of the pot, it requires simultaneous operation of crane and trolley to advance the tongs correctly. This maneuvering needs great skill of the crane operator, he has to move both the crane-bridge and trolley with short impulses of the respective motors; the cumbersome crane-bridge starts very diffidently and then overshoots the mark if the motor is left a moment too long in action; the trolley also, due to its small inertia, readily moves too far. Even with all the skill of an experienced operator it thus takes a relatively long time to withdraw or insert a pot; the furnace must be left open a long time and the tong shanks projecting into the furnace soon get so hot, that they open out when gripping the pots and start to scale off. They must therefore be of much stronger section and be more often replaced than when cranes as in Figs. 35-37 or tong trucks are employed. The frequent, short impulses in the motors of the trolley and the crane-bridge wear them out and also stress starters and rheostats very heavily, involving high maintenance charges.

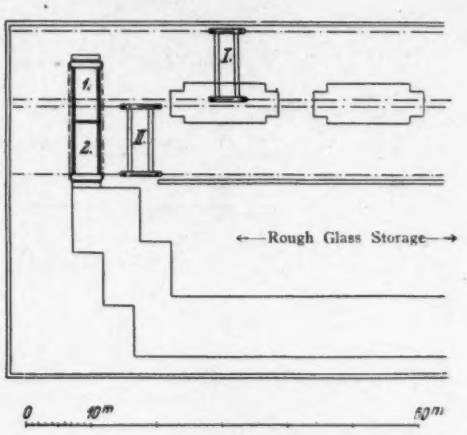

FIG. 54

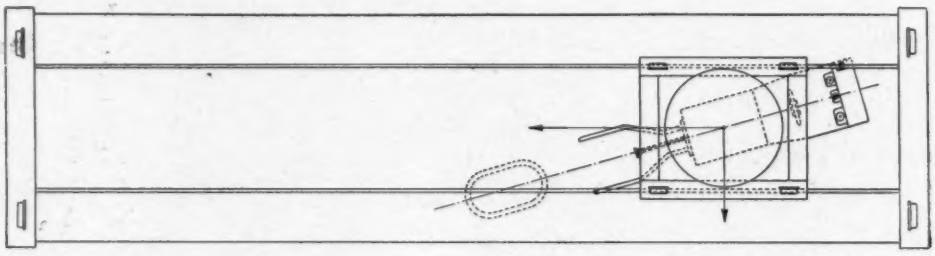

FIG. 55

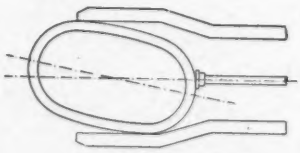

FIG. 56

Even the crane which does the pot-removing and casting in one operation has its drawbacks. With nearly oval pots, whose side walls have practically no straight stretch, it frequently occurs that they are not quite symmetrically gripped by the tong, but rather as shown in Fig. 56. The trouble referred to before, in withdrawing the pot from the furnace, causes this to happen quite frequently. Now a pot which does not hang with accurate symmetry in the tongs is not easy to pour; in flowing out the glass mass concentrates on a small section of the pot-rim only, and the crane operator and the man turning the pot can not distribute the glass evenly over the width of the casting table with the usual accuracy; further the danger arises of the glass mass folding over itself and entrapping air. It is for this reason that

in some factories using tong cranes it is usual to set the pots once more down before casting in order to grip them anew. To accelerate and facilitate this, the support on which the pots are set should be made rotary. This setting and re-gripping with the same tong goes much faster than the setting down and gripping with the tongs of a separate casting crane; however part of the advantage expected from such a tong crane is lost. The time taken in setting the pot down may be regained by fitting the pot support with scrapers during the setting down, clean the pot seat thoroughly, so that no dirt will fall therefrom on the casting table or in the glass heap. But as while it is being set down, not all parts of the pot seat can be got at with the mechanically operated scrapers, it must after all be cleaned by hand as well.

The skill required by the two men operating the tong crane for the proper pouring out of the pot is referred to again later. However, the advantage certainly exists that one has to rely on two men only, whilst the casting with the ordinary casting tongs engages 7 to 8 men. On the other hand with the casting tongs even unskilled men can soon be trained, whilst the tong crane needs really extra skill and ability.

The problem set in casting and rolling is to place the glass mass so that from the initial position of the roll over to the roll winch, the whole surface of the casting table between the "trams" is covered, and that as nearly as possible a rectangular sheet of uniform thickness and containing no inner impurities is produced. This sheet must be undamaged and without cracks and humps, and must be pushed into the annealing oven in time to equalize and reduce stresses, set up during rolling and cooling down on the casting table, to such a degree that the finished sheet will safely withstand the forces to which it is subjected in use.

The Figs. 57 to 59 show a removable casting table with roller and roller carriage, to an earlier design of the Beurather Maschinenfabrik A. G. (now the Deutsche Maschinenfabrik A. G.) for a rough glass factory with single annealing kilns, i.e., annealing ovens intended for one sheet only. These single kilns have to cool down completely with their charge and consequently have to be reheated again for the next sheet. The casting table and the roller carriage must therefore be brought in front of each kiln; the roller carriage contains the drive

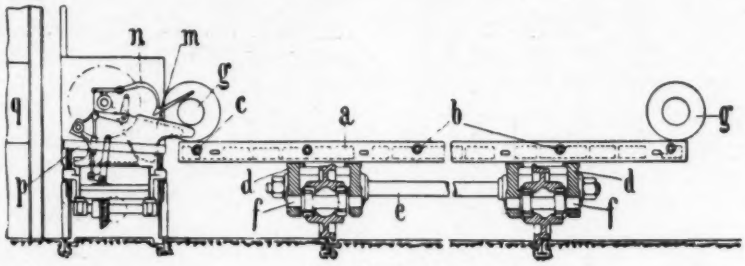

FIG. 57

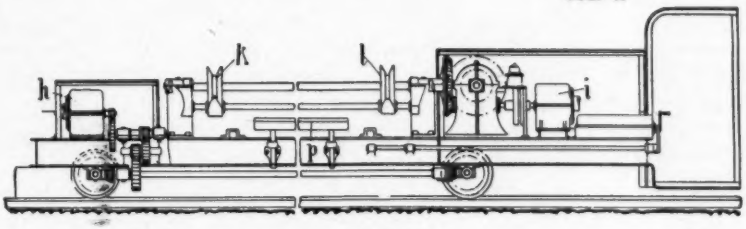

FIG. 58

with the electric motor h. By means of an engaging device the roller carriage also moves the casting table. The motor i pulls the roll with the aid of rope winches k and l. When the roll arrives at the roller carriage, its ends run on sloped faces m of the latter and finally are caught in the hooks n. At this moment the roller ends move a lever which switches the motor i off. By running up the slope m, the roll is sufficiently lifted for the finished rough glass sheet to be pushed beneath it into the annealing kiln q. In the process it slides over the plate p, serving as bridge between casting table and annealing oven. The shovel in its turn, when arriving at the end of its movement towards the kiln, operates a lever, switching the motor i off.

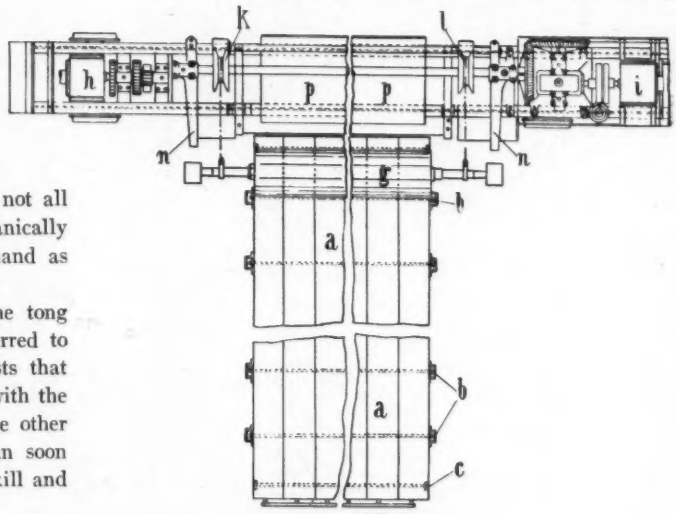

FIG. 59

(To be continued)

MacBeth-Evans Glass Co. Declares Dividend

MacBeth-Evans Glass Company declared the regular quarterly dividend of 1½ per cent on the $50 par value Stock, and an extra dividend of 1 per cent, payable December 22 to record December 15. This makes a total of 7 per cent for 1930.

Glass Industry

ESTABLISHED 1920

The First Trade Journal Devoted Primarily to Glass Technology, Engineering, Raw Materials and Glass Factory Equipment and Operation

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Vol. 12 JANUARY, 1931 No. 1

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Research

RESEARCH plays an increasingly important part in the modern world. Its value is attested to on every hand. Industries thrive on the manufacture of products evolved or improved by research; bankers chart their course through perilous financial crises with the help of data gathered by statistical research; merchants rely on research in advertising, sales methods, and merchandising to minimize the hazards of fluctuating markets; the housewife, buying a vacuum cleaner, places her confidence in that machine which has the recommendation of an institute of household research; the man in the street enjoys sounder health because he know something about vitamins and a balanced diet. Thus are our lives, and the life of business, conditioned by the findings of research.

In the industrial field, where laboratory science confers its fullest and most tangible benefits, the glass industry stands out as a monument to the value of research. Once the glassmaker hugged superstition to his bosom. A rabbit's paw was an invaluable adjunct to the art and mystery of mixing a batch of glass. Not many years have passed since ruby glass batches were mixed only in the light of the full moon, and a few veterans can remember when good glass had to be made exclusively with wood fires. Research has changed all that. No longer can the glassmaker explain away a long run of inferior glass with the assertion that "this is a poor year for glass." Superstition has been routed from modern industry.

Nevertheless, the practices of that day, while amusing to us now, were then no less detrimental to the industry than is the present deplorable tendency to discontinue research—at any time, and for almost any reasons. The excuses for such a step are seldom valid; the occasions for making it are usually ill-chosen. On the one hand, research activity is sometimes suspended because its cost is held to be excessive, or because attainment of a desired objective seems to make its continuation unnecessary. On the other hand, a period of slack business is deemed the proper time to dispense with scientific inquiry. The true, permanent value of research is overlooked.

The cost of research cannot be considered from the standpoint of immediate costs. To take so circumscribed a view is to ignore future eventualities. Tomorrow, next month, a year from now, a competitor may through research discover a superior product, a cheaper manufacturing process, a method for appealing to a bigger market without increasing production costs. If only in self-defense, the manufacturer must continue to look for ways and means whereby his services may be made better and more widely available. Beyond this lies his duty to the public which he serves. From this standpoint, research is an investment, not an expense.

To stop research when a definite goal has been reached is to invite disaster. Should American factories have been satisfied with making window glass by the cylinder method while the Belgians were experimenting with the Fourcault machine? It was predicted that good glass could not be made except by the blowing process. Today we have the Fourcault sheet drawing process, and at least two other similar processes which produce glass of a quality higher than

was thought possible before research evolved them. In the past history of the glass industry, the cylinder method of glassmaking stands as a warning not to halt along the road of progress.

That entire history, indeed, serves to emphasize the fact that research is the soundest insurance against obsolescence of process or product, and that to be consistently efficient it must be continuous in operation. So soon as we set research aside, so soon do we progress less swiftly, less surely. Without it we cannot but go backward. Research is indispensable to progress. This is true whether we speak of progress in the whole of our complex civilization, or of progress in industry. What we do today is conditioned by what we learned yesterday. The achievements of tomorrow depend in large measure upon what we learn today.

The present depression does not constitute a valid excuse for curtailment of research. On the contrary, this very condition affords an unparalleled opportunity for demonstrating the concrete value of broader, more extensive knowledge. Relieved from the necessity of aiding in control of production which presses upon the laboratory when business is good, research workers may in less prosperous times more readily concentrate their efforts on the larger problems. In sum, with business at low ebb, the programs of research should be promoted with greater vigor than ever. D. E. S.

The Glass Industry in 1931

WE think that we may fairly claim that THE GLASS INDUSTRY during 1930 published a great deal of very useful matter for the glass manufacturer and technologist. We believe that we lead the English speaking world in the extent and accuracy of our data. In accordance with the policy of our journal, we do not aim to publish highly mathematical or deeply scientific original researches, for which the proper media of publication are the journals of scientific societies, but we do believe that we are doing a good work in making the results of these scientific works easily comprehensible to the men in the shops, and in pointing out the practical bearings of the most recent researches. We also endeavor to publish accurate summaries of the present state of knowledge, and of the present state of the art, by the recognized authorities on the subjects.

We have received during 1930 a number of congratulations on our success in this matter, and in maintaining and improving our services in this respect.

During 1931 we believe we shall achieve a new record and set new standards; we have already on hand a number of important articles on many phases of the glass industry. During the year the publication of Herr Lutz's treatise on plate glassmaking will be continued to completion, and will be the first reasonably complete and authentic account in the English language of the plate glass industry. As a corollary to Mr. Lee's treatise on the development of the modern high speed photographic lens, Mr. Guilford of the Eastman Kodak Company will review that company's practice in the making of the lenses themselves.

Mr. Donald Sharp of Hamburg, N. Y., will review the literature and our present knowledge of several of the physical properties of glass.

Mr. C. E. Spencer of the General Electric Company will have something to say about the light transmitting properties of various glasses, and of high speed ways of obtaining the data.

The Corning 399, the famous electric bulb-blowing machine, will be described more completely and with more and better illustrations than has so far been attempted.

Dr. Morey of the Geophysical Laboratory at Washington has promised to review for the non-expert reader, the bearing of his researches on the crystallizing or devitrifying of glass.

THE GLASS INDUSTRY enjoys the warm support of so many of the best-posted men in the industry, that an adequate service to that industry by the paper, not simply as a recorder, but as a leader of its thought, is assured for 1931.

Forceful Statement of the Industry's Need for Publicity

By ROSS C. PURDY, General Secretary, American Ceramic Society

TO THE MEMBERS OF THE SOCIETY:

This message would not be addressed to you if it were not that several serious minded successful ceramic business executives advised it. They consider that the Ceramic Congress, which will be held in the Cleveland Auditorium during the week of February 22, is being held for you collectively and individually, and hence should have your support. It requires more than your support; it needs your participation if you are going to realize all the latent benefits which it is possible for you to obtain from this Congress.

"It pays to advertise." "You must tell the World and keep on with the telling." "The best product will not move unless a demand for it is created."

Such trite and axiomatic sayings apply to ceramic research and education the same as they do to coca cola or to china. If we are to develop in America a demand for American ceramic wares, we must bring the best possible skill and brain power into the art, science and technology of ceramic ware production. We must do this before we can hope to have the quality in design and product that will compare favorably with foreign made ceramics or with non-ceramic products. And having a product of superior quality we must be continually "telling the world."

Why is the American Ceramic Society sponsoring an Exposition? Are ceramic expositions outside of the scope and purposes of a Society organized to promote the ceramic art, science and technology? Is not an exposition wholly trade in character and results? These are fair questions. They will be answered.

Research on Sales Firing Line

A study of the organization charts and of the research program, and of the backbone of the up-to-date sales organizations of the rapidly growing and progressive manufacturing concerns will reveal the fact that the research laboratories and the technical personnel are on the sales firing line. Manufacturers' sales representation, once a peddling job, now requires the services of the artist and the technician. This is patently true in the selling of products for industrial use; it is rapidly becoming more evident in the wholesale selling of building and household materials. The ceramic artist and the ceramic technologist are today doing teamwork in the selling of terra cotta and wall tile. The engineer, architect and ceramic engineer are being broken into doing teamwork in the sale of brick and structural tile. The ceramic artist and the ceramic technologist must be in tandem in the sale of pottery.

Research Not Alone for Internal Development

The days are gone when the research laboratories and studios are concerned wholly and only on internal developments and control. Factory procedures and control, product development, and the creating of new products, are today directed to sales development and promotion. The buyers are greatly interested in the stability and

progressiveness of the manufacturers, as evidenced by the strength and vision of the research and control personnel at the factory. The aggressive manufacturers are advertising their research and control facilities and their personnel, and are putting them on the sales firing line. Why? To establish confidence and to focus the product development and control in advance of the market demands.

The ceramic art and technology personnel, in the aggressive manufacturing organizations, are as closely teamed up with the sales as they have in the past been teamed up with the production departments. The chemists and engineers in steel product concerns are today getting their leads and inspirations for factory and product developments by making first hand studies of their customers' requirements. Research and control must primarily be teamed with sales and secondarily with production.

This vision for the ceramic artists and technologists is not a product of reasoning. It is a natural development in the organization and management of agressive manufacturing concerns of all sorts. It is not a new vision. The manufacturing management which does not team his art and research with sales is more than a decade behind the times. If you do not have this vision, ought you not take counsel?

Ceramic Artists and Technologists Must Be Product-Minded

Based on twenty years of continuous experience in a manufacturer's technical organization, and based on observations of the research organizations of many of America's aggressive manufacturing concerns, I can state with confidence that one of the very serious deficiencies in our ceramic artists and technologists is their lack of product and sales market-mindedness. When asked in 1912 to establish a research organization, the Board of Directors were astonished with the inclusion of product development and promotion within the scope of research. Twenty years of experience of that concern have confirmed the soundness of having product development and promotion as one of the chief objectives of all research laboratories. Our ceramic artists and technologists must be product-minded.

We have tried different means for making our ceramic artists and technologists product-minded. We tried small scale expositions of products, and finding them to be effective, they were developed until they culminated into the first Ceramic Exposition, which was held in the Stevens Hotel, Chicago, in February, 1929.

That Exposition paid back to the ceramic industries all that it cost in effort and dollars in the very evident advance which has been made in making our ceramic artists, educators and technologists product-minded.

Thus is the Ceramic Exposition aimed at self-education and development, and since it is essential that our artists and technologists be product- and market-minded, so must their Society—your technical organization—be product-minded.

Ultimate Customers Must Be Ceramic-Minded

Your glass and pottery show, exclusively for buyers, without doubt stimulates the development of new lines. It gives opportunity to meet and exchange ideas with the buyers as a group. It is a spiritual blessing to both the buyers and to your sales representatives. It does not, however, reach the ultimate purchasers. It creates a demand for American wares only in a secondhanded fashion through the buyer. It does not build prestige with the public for your wares.

Manufacturers abroad have learned and are cashing in on the values of public expositions of their products. These expositions create a pride as well as a knowledge of homemade products. This pride is reflected in sales, and also in the directing of the artistic and scientific talent in the country to possible employment in the production of their ceramic wares.

The sales made or initiated at public expositions of products fall far short of the full measure of the economic value of expositions to the manufacturer. Public mindfulness of your product will reflect itself in sales not always traceable direct to the exposition. And public mindfulness of your product will reflect itself in larger artistic and technical resourcefulness, the two factors that are so important nowadays in holding a market. If foreign products and non-ceramic products are crowding your sales field may I suggest that we take stock of the greater resourcefulness as well as the larger public demands for their product which have resulted from expositions?

The benefits of expositions are most largely indirect; they are not reflected in sales at the exposition. . . .

Our Citizens Are Not Ceramic-Minded

Evidences are plentiful that ceramic manufacturers are not reaching the public; the public is not conscious of the high merits of American made ceramics. The jobber, the buyer, and other middlemen have been for altogether too long a while the sales representatives of our ceramic manufacturers in direct contact with the ultimate purchaser.

Why is the American Ceramic Society concerned about this? The answer is that for thirty-two years this Society has made effort to interest the educational and research resources of the country in ceramics. A great deal has been accomplished, but the progress and accomplishments made have been woefully short of the ceramic industrial needs.

To show what I mean, let me cite the situation in Ohio. Notwithstanding Ohio being the largest ceramic producer as rated by value of products sold, having started the world's first collegiate ceramic school, and being the birthplace and home of the American Ceramic Society, The Ohio State University Engineering Experiment Station had for fifteen years been engaged on tests and studies of every type of product other than ceramics. The ceramic manufacturers were not making demands. The legislators did not know the value of Ohio's industrial ceramics. The University was responsive, but was without both money and requests for ceramic research. To correct this situation we had to stage a ceramic exposition, organize the Ohio Ceramic Industries Association, labor with code committees, outline a program for high school ceramic courses, a Ceramic Art Department at the University, a ceramic research professor, the Roseville Ceramic Research Station, and to campaign for appropriations for ceramic research at the Experiment Station. If these activities have not impressed you, and if you have not been giving them support, may I ask what can be done to impress you? And may I ask you to judge what greater efforts must be made to impress the state officials and legislators with the importance of financing ceramic art and technology?

We must be acquainting our citizens of the large industrial value of industrial ceramics before we can obtain the financial support of ceramic research and education in our several states and nationally. In comparison with other industrial groups, the ceramic industries are not getting for research and education anywhere near their proportionate share of the appropriations made.

The American Ceramic Society sees the value of ceramic expositions in obtaining these appropriations. They greatly lessen the legislative resistance born of ignorance of what ceramics is in fact and in industrial value.

Summary

1. We must tell and show. We cannot otherwise reach the purchasing citizens.
2. Research in ceramic art and technology should be directed primarily to ceramic ware development and promotion, and secondarily to plant development and control.
3. Ceramic artists and technologists must be product-minded.
4. Ultimate customers must be ceramic-minded, not alone to make purchases of domestic made ceramic products, but also to make available to ceramic ware production the artistic and scientific resources of our country.
5. Before ceramic industries can obtain the employment on their problems, their share of the large, publicly financed educational and research facilities of this country, we must by ceramic expositions and ceramic congresses make our citizens and our legislators conscious of the importance of ceramics industrially, and of the high qualities of ware now being produced.

The American Ceramic Congress, with its Meetings and Exposition, is set up for your benefit. These have been provided by well-informed business men who have thought through to practical conclusions on what must be done to place American ceramic industries on a better paying basis. This Congress and the Exposition deserves your support.

Glass Division Members and Guests

Make your Hotel reservations at once for the A.C.S. annual meeting at Cleveland, Ohio, February 23-27.

The Hotel Hollenden, close by the Cleveland Auditorium, where the American Ceramic Exposition will be held, is Glass Division Headquarters.

Come and have a good time—see your friends in the Cove Point movies.

How to Reduce Breakage in Glassware

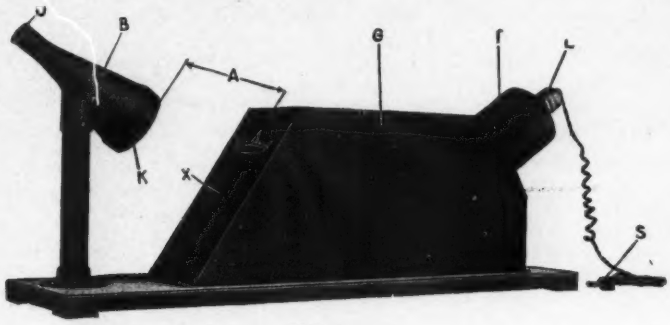


FIG. 1

By RENE LEONHARDT, Berlin, Germany

THIS question is of great importance to every manufacturer of glassware as well as to every wholesale or retail glass dealer.

The strain-viewer hereafter described makes it possible to detect the strains resulting from the cooling process.

The figure above represents a glassware strain-viewer of a type now obtainable. The rays from a lamp L are polarized by means of a curved mirror of smoked glass, mounted horizontally on a baseplate, and are reflected through the aperture X and the viewing-tube B. The condensing lens K, which serves the double purpose of concentrating the reflected rays and magnifying the field of view, throws the whole of the light through an "analyzer" situated at the eyepiece O, consisting of a Nicol prism with a suitable "optical medium" (a plate of mica or gypsum) placed in front of it. One of the Nicol prisms in this appliance is replaced by the curved mirror of smoked glass. The purpose of this is to provide an angle of view wide enough for practical purposes. To make Nicol prisms of such dimensions is out of the question, owing to the rarity of the material employed (calc-spar). With the lamp L removed, and a ground glass screen put in its place, the apparatus can be used by daylight or other illumination. The object to be examined is held in the interstice A between the observation tube E and the casing G, at such distance from the condensing lens K mounted in the lower part of B, that the observer on looking through O gets a sharp image.

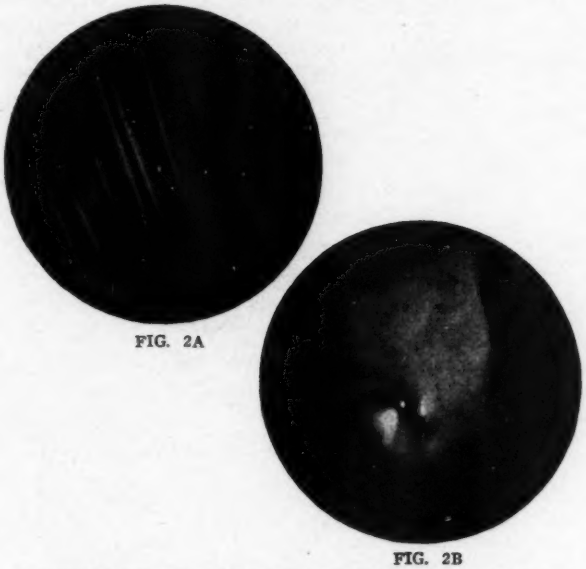


FIG. 2A

FIG. 2B

CHARACTERISTIC APPEARANCE OF STRAIN IN THE GLASS

Figs. 2a and 2b show two varieties of tension; 2a is a case of streaks down the length of a glass bottle, due to strain caused by the irregular functioning of a bottle-blowing machine, while 2b is a patch of strain, prejudicial to the resistance of the bottle, probably traceable to faulty mixing of the molten material.

In order to get a permanent photographic record of strains as shown in Figs. 2a and 2b, a camera can be set up in the place of the eyepiece at O (Fig. 1).

By the aid of an optical medium, which again should be either gypsum or mica, it is possible to produce in the field of view a range of tints from which the extent of the excessive strain can be judged. It will be seen from Fig. 1 that the strain-viewer there illustrated is only capable of dealing with articles that do not exceed a certain size.

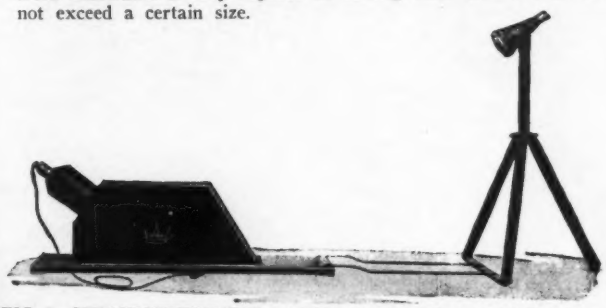


FIG. 3—STRAIN-VIEWER FOR LARGE ARTICLES OF GLASSWARE

Fig. 3 shows a type of apparatus with which articles up to 39" in diameter can be examined. For convenience in transport as well as in actual use it is advantageous to have the apparatus in three separate parts that are easily set up as required.

Fig. 4 shows a portable strain-viewer, that is on the market, ready for use. The box K on hinges S1 and S2 is held down on the base board G by the spring catch H. The aperture O1 and O2 needed for the working of the apparatus, are covered by flaps when not in use. The nickel plated handle T is provided for convenience in carrying.

The apparatus is connected to the electric lighting current, or daylight may be used with the aid of a diffusing screen.

These glassware strain-viewers are made by the Askania Werke A.G., Bambergwerk, Berlin-Friedenau, Germany, Kaiserallee 87-88.

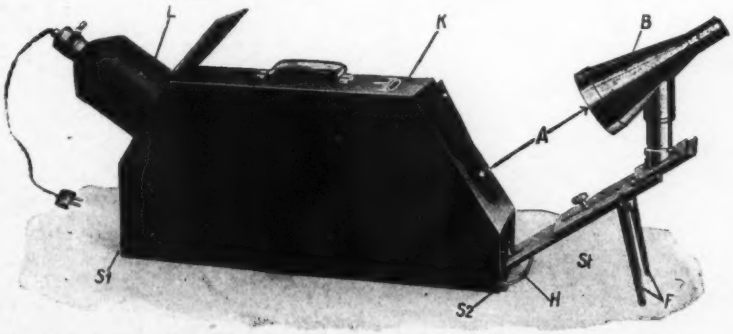


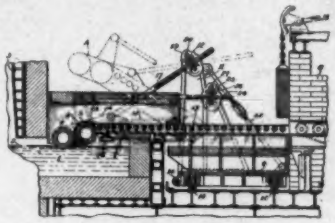
FIG. 4—PORTABLE STRAIN-VIEWER ERECTED AND READY FOR USE

Recent Patents

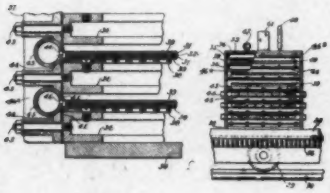
NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C., Price 10c each

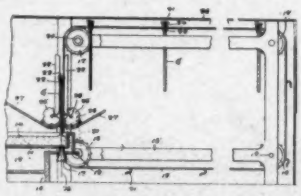
APPARATUS FOR MAKING PLATE GLASS. U. S. 1,775,125. Sept. 9, 1930. Frederick Gelstharp, Tarentum, Pa., assignor to Pittsburgh Plate Glass Company. Filed 11/25/27. In combination, a glass tank containing a body of molten glass and open above a portion of the bath, a pair of horizontal driven sizing rolls above said portion of the bath, one of which has its periphery immersed in said body of glass, while the other lies alongside such roll with its axis in a vertical plane, spaced in a horizontal direction to the side of the vertical plane in which the axis of the first roll is located, but a higher level so that its periphery lies above the surface of said body of glass, means for cooling the rolls, so as to prevent the glass from sticking thereto, and means for supporting and carrying away the glass which is delivered upward from the rolls.



APPARATUS FOR MAKING COMPOSITE GLASS. U. S. 1,775,123. Sept. 9, 1930. John H. Fox and William Owen, Pittsburgh, Pa., assignors to Pittsburgh Plate Glass Company. Filed 12/17/26. Apparatus for applying heat and pressure to a set of sheets to be joined together comprising a tank having a side wall with a plurality of parallel slots therethrough and provided with a plurality of communicating compartments, each opening through one of said slots, a flexible container in each compartment also opening through one of said slots and each adapted to carry a set of sheets, and a header secured over the open side of the tank, arranged so as to clamp the ends to the flexible containers against the outer face of said side wall of the tank, and provided with slots opposite the ends of said containers, and pipes releasably carried by the header in opposition to said slots for holding the ends of said containers against outward movement when hydraulic pressure is applied to the tank, the said pipes being provided with openings on their sides next to the ends of said containers.



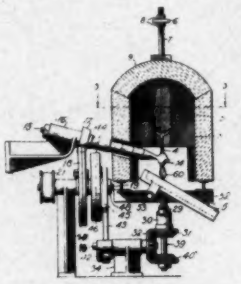
GLASS-DRAWING MACHINE. U. S. 1,778,590. Oct. 14, 1930. Benjamin F. France, Portsmouth, O. Filed 2/18/27. One of the objects of the invention is to provide means for utilizing the waste heat from the melting furnace for annealing the continuous sheet of glass after being drawn vertically from the furnace. Another object is the provision of novel means for cutting the glass into sheets and gripping said sheets while the latter are annealed, so that the sheets will not be handled until properly cooled and thereby preserve their finish.



COMPOSITE PLUNGER FOR GLASS FEEDERS. U. S. 1,780,550. Nov. 4, 1930. William T. Barker, Jr., Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn. Filed 3/10/27. In a glass feeder, a composite flow-controlling implement comprising a plunger provided with an adjustable collar immersed in the glass and fitting the plunger closely enough to substantially prevent passage of glass between the plunger and the collar.

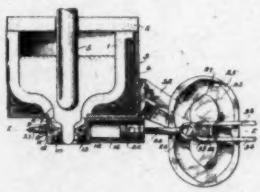
PROCESS AND APPARATUS FOR THE MANUFACTURE OF GLASS. U. S. 1,789,590. Nov. 4, 1930. Charles Heuze, Auvelais, Belgium, assignor by mesne assignments to The American Bicheroux Company, Delaware. Filed 6/19/28 and in Belgium 3/3/28. The process of manufacturing and annealing glass sheets, comprising forming a sheet at high speed and delivering the same as formed to a train of rollers, the axis of the train being in line with the axis of the forming machine and the peripheral speed of the rollers being the same as the speed of sheet formation, moving the sheet while on the train tranversly out of alignment with the forming machine instrumentalities and in alignment with a lehr, and feeding the sheet off the train of rollers and towards a lehr at a reduced speed by continuously rotating the rollers of the train at a reduced speed.

ART OF FEEDING MOLTEN GLASS. U. S. 1,773,544. Aug. 19, 1930. Karl E. Peiler, Hartford, Conn., assignor to Hartford-Empire Co. Original application filed 8/3/12. Divided and this application filed 3/7/16. The molten glass flowing from the outlet of a melting furnace or other receptacle is wound or coiled or rolled upon itself until the desired amount of glass is accumulated, whereupon the winding or coiling operation is partly or wholly arrested or reversed, or otherwise varied so as to shed or discharge the accumulation, the separation being aided if desired by any suitable severing device. These alternate accumulating and shedding operations are repeated and regulated as to rapidity of occurrence and the amount of glass fed, by suitably adjusting the rate of flow of the glass and the frequency of the shedding operations.



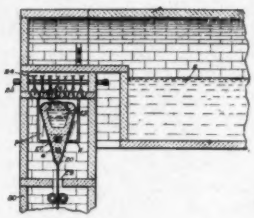
METHOD AND APPARATUS FOR MANUFACTURING GLASSWARE. U. S. 1,778,743. Oct. 21, 1930. Wilbert S. Williams and David L. Middendorf, Columbus, O., assignors to The Federal Glass Company, Columbus, O. Filed 11/23/27. The method of producing stemmed and footed glassware which comprises pressing a blank with an abnormally heavy end, heating such end, bringing shaping rollers into contact with such end, and causing relative longitudinal movement between said rollers and the support for said blank and relative rotation between such end and said shaping rollers to shape such end and force its extremity into a foot mold and then continuing the operation of said rollers in cooperative relation to said foot mold to produce a foot, and then blowing the blank.

METHOD AND APPARATUS FOR SEVERING MOLTEN GLASS. U. S. 1,775,199. Sept. 9, 1930. George R. Haub, Washington, Pa., assignor to Hazel-Atlas Glass Co., Wheeling, W. Va. Filed 8/1/27. An object of the invention therefore resides in the creation of a severing means in the form of a thin, knife-like flame of extremely high temperature and pressure, by the use of an explosive mixture, and in directing this knife-like flame traversely through the column of molten glass protruding through the outlet of the flow spout so as to sever therefrom a charge or gob of molten glass without in any way chilling the glass. Gas charges are periodically compressed in the explosion chamber 8 and for the purpose of exploding these charges the inventor provides a conventional spark plug 35 which is secured in place in the cylindrical wall 11 in the usual manner with its terminals positioned in the explosion chamber. The spark plug is placed in an electric circuit which also includes a timer 36 of ordinary



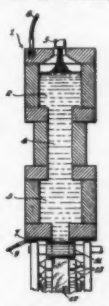
construction except that it has only a single contact. This timer is connected with the drive shaft 26 and thus serves to close the circuit through the spark plug once during each rotation of the shaft; the drive shaft, of course, being geared or otherwise connected to the usual forming machine so that the entire mechanism is properly synchronized. A charge of highly compressed explosive gas is placed around the glass column and exploded, thereby intermittently creating an intensely hot flame under high pressure which is directed through the glass column in a knife-like stream so as to make a clean cut through the glass without any deleterious effects, such as chilling of the upper surface of the severed gob or of the depending stub of glass which will form the lower end of the succeeding gob. Obviously the invention contemplates the use of any desired explosive mixture, such as gasolene vapor and air, acetylene and oxygen, etc.

APPARATUS FOR PRODUCING SHEET GLASS. U. S. 1,772,448. Aug. 12, 1930. Horace E. Allen, Toledo, O., assignor to Libbey-Owens-Ford Glass Company, Toledo, O. Original application filed 1/10/21. Divided and this application filed 10/10/24. Apparatus for producing sheet glass, a container for molten glass having a longitudinal opening at the top, means for supplying molten glass to the container so that the glass will flow through the opening and down the two sides of the container, the two streams of molten glass uniting below the container, means for mounting the container for tiltable and vertical adjustment, and means for carrying away the united streams as a single sheet of glass.



APPARATUS FOR SEVERING COMPOSITE GLASS. U. S. 1,771,510. July 29, 1930. Nicholas J. Penning, of Pittsburgh, Pa., assignor to Duplate Corporation. Filed 12/13/28. Relates to apparatus for severing composite glass sheets by the application of heat preferably by the use of heat generated by the passage of electric current through resistance elements. All defects incident to the operation lie on one side of the line of cut, in the strip of waste glass, which is cut off.

APPARATUS FOR MAKING SHEET GLASS. U. S. 1,761,342. June 3, 1930. Harry F. Hitner, Oakmont, Pa., assignor to Pittsburgh Plate Glass Company, Pittsburgh, Pa. Filed 2/4/29. A tank, a metal electrode constituting a part of one of the walls of the tank and having a slot therethrough, means in opposition to the slot for receiving and carrying away the glass flowing from the slot, a second electrode at a point remote from said first electrode positioned so as to transmit current to the glass in the tank at said point, and means for supplying electric current to the electrodes.



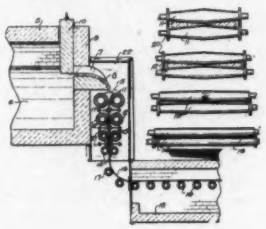
PROCESS OF MAKING COMPOSITE GLASS. U. S. 1,771,416. William Owen, of Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Company. Filed 11/2/28. Composite glass plates develop a tendency to separate or "let go" at the edges. The inventor has found a means of entirely overcoming this separation without employing the sealing operation. Instead of cutting the sheets to approximately finished size, as has heretofore been done, they are cut oversize, ordinarily about one inch greater in length and width than the plate to be produced. The sheets are then composited in the usual way, and the plate thus produced is trimmed down to exact size by the use of an abrading wheel which acts as a saw.

PROCESS AND APPARATUS FOR POLISHING PLATE GLASS. U. S. 1,771,408. July 29, 1930. Halbert K. Hitchcock, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Company. Original application filed 10/29/23. Divided and this application filed 4/7/28.

GLASS-SURFACING APPARATUS. U. S. 1,771,404. July 29, 1930. Albert E. Evans, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Company. Filed 6/25/28.

ABSORPTION GLASS. U. S. 1,771,435. July 29, 1930. Frederick Gelstharp, of Tarentum, Pa., assignor to Pittsburgh Plate Glass Company. Filed 12/11/26. A clear glass having a blue tinge when first made with high ultra-violet ray absorbing properties containing cerium oxide, and formed by fusing a cerium compound of chemically pure quality in a reducing batch with one-fourth to one-half ounce of cobalt oxide in a batch approximating 1,700 pounds.

PROCESS AND APPARATUS FOR FORMING SHEET GLASS. U. S. 1,772,072. Aug. 5, 1930. John L. Drake, Toledo, O., assignor to Libbey-Owens-Ford Glass Co., Toledo, O. Filed 10/6/27. One object is to provide a process and apparatus wherein a plurality of pairs of rolls are preferably arranged in superimposed relation, a relatively thick, narrow stream of molten glass being flowed upon the uppermost pair of rolls and passed downwardly through the succeeding pairs, each succeeding pair of rolls serving to reduce the thickness of the stream while simultaneously increasing its width, the molten glass being spread from the center outwardly.



GLASSWARE-ANNEALING LEHR. U. S. 1,771,876. July 29, 1930. Albert N. Cramer, Toledo, O., assignor to Owens-Illinois Glass Company, Toledo, O. Filed 5/11/28. There is provided means whereby the most effective portions of the heating medium in the heating zone may be held in the areas occupied by the ware, regardless of its height, to thereby insure proper heating of the ware.

METHOD AND APPARATUS FOR COLORING THIN GLASS BODIES. U. S. 1,767,108. June 24, 1930. Edward A. Zeh, Passaic, N. J., assignor to Zeh, Inc., Clifton, N. J. Filed 3/16/28. Constitutes an improvement over the method disclosed in copending application Serial No. 192,482 filed May 18, 1927.

PLATE-GLASS-POLISHING APPARATUS. U. S. 1,782,475. Nov. 25, 1930. Frederic Merian and James W. Cruikshank, Pittsburgh, Pa., assignors to Pilkington Brothers Limited, Lancashire, England. Filed 8/6/25.

METHOD AND APPARATUS FOR MAKING SHEET GLASS. U. S. 1,782,972. Nov. 25, 1930. William L. Monro, Pittsburgh, Pa., assignor to Window Glass Machine Company, Pittsburgh, Pa. Filed 2/16/24.

TAKE-OFF DEVICE FOR GLASS-FORMING MACHINES. U. S. 1,771,576. July 29, 1930. Harry B. Lawson, of Huntington, W. Va., assignor to Ball Brothers Company, Muncie, Ind. Filed 11/3/24.

GLASS CONVEYER. U. S. 1,770,039. July 8, 1930. Jules Mayeur, Sr., Richmond, Va., assignor of one-half to Clarence H. Gilbert, Richmond, Va. Filed 1/27/27. For conveying sheet glass from the oven.

SHEET-GLASS HANDLING MECHANISM. U. S. 1,782,716. Nov. 25, 1930. Vernon M. Dorsey, Chevy Chase, Md., assignor to The American Bicheroux Company, Wilmington, Del. Filed 4/13/29.

APPARATUS FOR HANDLING GLASSWARE. U. S. 1,766,574. June 24, 1930. Daniel B. Westin and Henry W. Ingle, Hartford, Conn., assignors to Hartford-Empire Company. Filed 6/1/26.

APPARATUS FOR SEPARATING GLASS SHEETS. U. S. 1,765,814. June 24, 1930. Charles H. Wright, Mount Vernon, Ohio, assignor to Pittsburgh Plate Glass Company. Filed 8/30/28.

APPARATUS FOR HANDLING GLASSWARE. U. S. 1,766,573. June 24, 1930. Daniel B. Westin, Hartford, Conn., assignor to Hartford-Empire Company. Filed 6/22/26.

MANUFACTURE OF SPLINTERLESS GLASS. U. S. 1,782,852. Nov. 25, 1930. John Jeffray, Ealing, London, England. Filed 12/4/29 and in Great Britain 11/12/28.

Developments in the Use of Borax

Considering the relatively short period in which the use of borax has been seriously undertaken by manufacturers of glass containers and pressed and blown ware, it is interesting to observe how consistently the consumption of this material has increased. Experimentation with borax has been widespread. A few have used it for a number of years, but especially during the last two or three years, the use of borax has become quite general, and the results gained have been generally satisfactory.

Interesting and valuable experimental work has been carried out by the Society of Glass Technology in England, and this work done on a small scale, has been supplemented by commercial applications not only in the United States, but also quite generally in England and in other countries.

It seems to be true that few developments in the manufacture of glassware have received more general consideration than has the use of borax. This may be due partly to the fact that for many years various of the beneficial effects obtainable with borax and B_2O_3 have been known in connection with the manufacture of various types of special glasses. Certain physical properties imparted to glass have been carefully determined and confirmed. These same properties are, of course, desirable in container glasses, and the part played by the glass manufacturers has been to determine how borax can be used in these types of glasses to get the benefits predicted. There has been present always the need of reconciling the results obtained in small scale laboratory experiments with the commercial results obtained in glass tanks.

That the use of borax is generally accepted as beneficial, and is expanding is readily evident from the fact that during 1929 about 7,500 tons of borax were used, not including that used in heat-resisting and other special glasses. During 1930, it is estimated that the consumption will reach around 11,000 tons. It is estimated that in the United States, there are about 400,000 tons of glass per year being made from batches which contain borax. Indications are that borax is being used generally in about forty plants, many of which are using continuous tanks and automatic machine production.

Needless to say, there have been reports of marked success with the use of borax, and there have also been reports of instances where difficulties have been met with. It has been quite generally shown that the melting capacity of continuous tanks can be increased with the use of borax. Coupled with this fact, however, it has also been shown that in order to take advantage of such increased melting, one must be able to put extra pull on the tanks. Some have reported a tendency for devitrification to develop, but others have overcome such tendency by general adjustment of the batch.

Recently at a meeting of the Society of Glass Technology in Buxton, England, these points and others were discussed. There was also brought out by some, a necessity in some instances for a slightly higher temperature at the working end of the tank when borax is used, to overcome the tendency of borax to increase the hardness and rate of setting of the glass. There was also discussed the possible effect of the addition of borax to an operating tank which might cause a temporary color to develop in the glass due to the more fluid melt acting upon the darker glass, which is apt to be present in dead portions of the tank. There is still much to be learned as to the movement of glass in tanks, and the evidence seems to show that where a slight color is developed, it has subsequently disappeared, and the ultimate effect of using borax makes it possible to get a satisfactory color with less decolorizer.

The separate and joint effects of borax and alumina have also come in for consideration. Some have reported that alumina can be more easily incorporated into the glass when borax is present, while others have pointed out that the use of a small proportion of alumina added as feldspar is desirable to develop the full benefits of borax.

Generally speaking, the reaction of glass makers to the use of borax has been favorable. Some manufacturers have been able to gain more definite benefits than others. Probably, no one familiar with glass technology feels that the technique in using borax is definitely established. It seems probable that more definite knowledge as to the operation of glass tanks may clear up some points now under discussion.

That manufacturers generally are convinced of the desirability of using borax in container glassware is evidenced by their desire to carry out experiments; sometimes at considerable cost to themselves. Where it is necessary to carry on experimentation and at the same time keep up production schedules, obviously the glass manufacturer is obliged to proceed cautiously. Yet there are definite reports of glassmakers who are obtaining increased melting capacities in tanks and increased production with consequent lower costs. Others mention other advantages. Even in the few instances where some difficulties have developed, it is recognized that there are benefits obtainable with the use of borax. Reports indicate still wider use of it during the coming year and it is expected that makers of flat and plate glass will give more consideration to its use.

Will Windowless Buildings Become Common?

Predictions were made at a meeting of The Illuminating Engineering Society, Richmond, Va., several weeks ago that we may in time arrive at a windowless age and according to the Society it was agreed that such a transition is not unthinkable.

Some group which has an incentive to eliminate windows will convince the public that it is useless and unwise to install glass, unless glass manufacturers train the public to clean windows and skylights more often. Moreover the proponents of such a revolutionary step would have powerful arguments in their favor.

Twenty to twenty-five per cent of the total light available at a window may be lost on account of the dirt accumulated during a four month period between cleanings according to an investigation by Professor H. H. Higbie and assistant professor H. S. Bull of the University of Michigan. This applies to windows in a comparatively clean location. In areas subject to more than average air polution the loss of light may run from twenty-five to fifty per cent, it was said.

The decrease in the light transmitting ability of glass due to dirt is not at a uniform time-rate, but is more rapid immediately after cleaning than when the glass is already dirty. Also, it was explained, the rate of deterioration depends upon the character as well as the amount of roughness on the glass surface.

The difference between transmission factors for wired and unwired glass ranges between 8 and 12 per cent, while differences in thickness do not affect the results materially, the experiments indicated. Hot water and cleansing powders are not sufficient to thoroughly clean windows, it was discovered during the investigation. The added requirement, say the co-workers, is elbow grease, and lots of it.

An interesting fact bearing on the subject is that a contract has been let to the Austin Company of Cleveland, Ohio, for the construction of a large entirely windowless building. The same company has developed an efficient method for welding instead of riveting the component parts of steel buildings and other structures. This method of operation entirely eliminates the noisy riveter, which makes itself such a nuisance especially in the construction of city buildings.

The method of utilizing electric welding, according to the General Electric Company, is growing fast. Eighty-four cities and towns in the United States have been added to the list of those permitting the use of this new construction method. The tallest building so far erected by electric welding is 19 stories in height. Improvements have been made in welding machines, including those applying the atomic-hydrogen process for industrial use.

November Construction Contracts

November contracts for new construction of all types awarded in the 37 states east of the Rocky Mountains totaled $253,573,700 according to F. W. Dodge Corporation. This compared with $337,301,400 in October and $391,012,500 in November, 1929. Of the November, 1930, total $101,096,000 was for new non-residential buildings; $80,781,900 for residential structures; and $71-695,800 for public works and utilities. Total new construction contracted for during the eleven elapsed months of 1930 was valued at $4,275,598,600 as compared with $5,437,922,400 for the corresponding eleven months of 1929.

Of the thirteen Dodge territories eleven showed declines in November from both the preceding month and November, 1929; the New Orleans territory alone showed gains over both periods; while the Pittsburgh district showed a gain over November, 1929, and a loss from October, 1930.

The Glass World and What It Is Doing

News of the Industry

American Ceramic Congress

The American Ceramic Congress to be held at the Auditorium, Cleveland, Ohio, during the week of February 22-28, 1931, will include the following organizations:

The Chicago World's Fair Ceramic Association.
The American Refractories Institute.
The National Brick Manufacturers Association.
The Grinding Wheel Manufacturers Association.
The Feldspar Grinders Institute.
The American Ceramic Society.

A Ceramic Exposition of products, materials and equipment will be opened in the Cleveland Auditorium beginning Sunday, February 22, at the Hotel Cleveland. The trustees and directors, also committees will meet. The president's reception will be held in the same hotel at 3:30 P. M.

The meeting of the American Ceramic Fellows will be held Sunday evening 8 P. M., General Edward Orton, Jr., chairman, and Monday, February 23, at 9:30 A. M. There will be a general combined meeting at the Public Auditorium.

The Exposition of Ceramics will be opened in the Public Auditorium from 1 to 10 P. M.

The materials and equipment division will hold a banquet at the Hotel Hollenden at 7 P. M. on Monday, L. E. Riddle, chairman.

On Tuesday the technical meetings by various industrial divisions will get started.

The paper will be read at the Public Auditorium from 9:30 A. M. to 1:30 P. M.

The American Ceramic Society Division Dinners and Business Meetings will be held at 6:30.

The Glass Division will be at the Hotel Hollenden. Art at the Hotel Statler and Refractories at the Hotel Cleveland.

On Wednesday the American Ceramic Society will hold its general meeting in the Cleveland Public Auditorium at 8 P. M.

Grinding Wheel Manufacturers will hold their meeting at the Hotel Cleveland, 2 P. M., Thursday. There will be a general session combined in the Public Auditorium on Thursday, at 2:30 P. M., to discuss management and processes.

Feldspar Grinders' Institute Standards meeting and luncheon, at 7 P. M., Hotel Hollenden.

Chicago World's Fair Ceramic meeting 9:30 to 12:30 P. M., and 2 to 6 P. M., Hotel Statler, Friday, February 27.

Railroads are offering 1½ round trip fare on the certificate plan.

The Refractories Division headquarters will be at the Hotel Cleveland; Art Division, Hotel Statler; Glass Division. Hotel Hollenden; Materials and Equipment Division at the Hotel Hollenden; Feldspar Grinders' Institute, Hotel Hollenden.

GLASS DIVISION PAPERS

Desirable Tariff Revision Concerning Original Works of Art in Glass.
By Alexander Silverman, University of Pittsburgh, Pittsburgh, Pa.

The Design and Construction of Polariscopes for Use in the Glass Factory.
By C. D. Spencer, General Electric Co., 1133 E. 152nd St., Cleveland, Ohio.

Preliminary Discussion of the Flow of Glass Subjected to Strain.
By C. D. Spencer, General Electric Co., 1133 E. 152nd St., Cleveland, Ohio.

A Review of Petrographic Work in Glass Technology.
By C. G. Harman, Ceramics Dept., Iowa State College, Ames, Ia., Selenium Dioxide as a Constituent of Glasses.
By Louis Navias and John Gallup, Research Laboratory, General Electric Co., No. 1 River Rd., Schenectady, N. Y.

Strains in Wire Glass.
By F. W. Preston, 500 N. McKean St., Butler, Pa.

Fissures in Glass and Other Materials.
By F. W. Preston, 500 N. McKean St., Butler, Pa.

Some Reflections on the Work of Morey on Liquidus Equilibrium, and Its Bearing on Other Recent Researches.
By F. W. Preston, 500 N. McKean St., Butler, Pa.

A New Light-Source for Absorption Measurements of Glasses in the Ultra-Violet.
By Willi M. Cohn, Berlin W. 50, Bambergerstr. 58, Germany.

The Infra-Red Absorption of Quartz and Its Modifications.
By Mrs. Dr. Cohn-Tolksdorf, Berlin W. 50, Bambergerstr. 58, Germany.

Index of Refraction of Some Soda-Lime Glasses as a Function of Their Composition.
By C. A. Faick and A. N. Finn, Bureau of Standards, Washington, D. C.

Direct Determination of Soda in Soda-Lime Glasses.
By Francis W. Glaze, Bureau of Standards, Washington, D. C.

Granular Feldspar with a Uniformly Low Iron Content.
By J. H. Weis, United Feldspar Corp., 10 E. 40th St., New York, N. Y.

Cleveland Backs American Ceramic Exposition

Cleveland's retail outlets for ceramic products have provided full cooperation with the American Ceramic Society in connection with the American Ceramic Exposition which will be held in Cleveland the week of February 23, 1931. Leading department stores and others handling glass and pottery have agreed to feature the exposition in their advertising and to arrange for the display of American-made ceramic products before and during the show.

A number of the leading American glass plants and potteries have contracted for space in the exposition and will display their products to the tens of thousands of Clevelanders who will be attracted to the Exposition by the extensive and thorough publicity campaign which is already under way as 150,000 cards of invitation will soon be mailed through Cleveland stores and these will be supplemented later by invitations issued through other agencies. It is estimated that at least 100,000 of Cleveland's buying public will see the Exposition.

Professor King Visits Sheffield Technical School

TO THE EDITOR:

The School of Glass Technology at the University of Sheffield, England, is probably the best known and most productive school of this type in existence. Dr. W. E. S. Turner, its chief, is a great worker. Even though handicapped by a recent illness from which he was still recuperating at the time of our visit, he was eager to return to his work.

The physical equipment of this school is some distance from the main university. The University purchased an abandoned glass plant and Professor Turner and his efficient staff remodeled and equipped parts of it for laboratories.

A large number of glass manufacturers are interested in this school and contribute to its support and the school does a large amount of work for them.

A great deal of work is done on the development of methods for analysis of glass, and is studying the physical properties of various glass compositions. One investigation has as its purpose the determination of what happens to glass when certain chemicals react with it.

There are the chemical testing department, the physical testing department and the furnace rooms. One furnace is large enough to hold and heat a large glass pot, and hence glass can be made and studied under conditions closely approximating ordinary commercial processes.

At the time of our visit some glass machines were being installed for studying the problems contingent to the forming of glass containers.

It was not only our privilege and pleasure to visit Dr. Turner's famous school but we also enjoyed the hospitality of his delightful family.

R. M. KING,
Assistant Professor Ceramic Engineering,
Ohio State University.

Power and Mechanical Engineering Exposition

The Ninth National Exposition of power and mechanical engineering was held successfully in New York at the Grand Central Palace, December 1-6.

Displaying the latest fruits of research and science in the realm of industry the exposition presented under one roof exhibits gathered from far and near. The hundreds interested who flocked to the Grand Central Palace had an excellent opportunity to study at first hand the improvements and progress shown in the various types of equipment they were interested in.

Among the equipment shown there was one departure of note, that being a variable speed metal belt so constructed as to change its speed from 265 to 1,590 r.p.m. merely by adjusting a lever.

Aside from power equipment there were to be found numerous products of particular interest represented by the following concerns:

American Water Softener Company, Philadelphia, Armstrong Cork & Insulation Company, Lancaster, Pa., Babcock & Wilcox Company, New York, Bausch & Lomb Optical Company, Rochester, S. F. Bowser & Co., Inc., Fort Wayne, The Bristol Company, Waterbury, The Brown Instrument Company, Philadelphia, Buffalo Forge Company, Buffalo, Carborundum Company, Perth Amboy, Carrier Engineering Company, Newark, Cooper Hewitt Electric Company, Hoboken, Foote Bros. Gear & Machine Co., Chicago, Gears & Forgings, Inc., Cleveland, General Electric Company, Schenectady, Harbison-Walker Refractories Co., Pittsburgh, Johns-Manville Corporation, New York, Keller Mechanical Engineering Corporation, Brooklyn, Leeds & Northrup, Philadelphia, Link-Belt Company, Chicago, Norton Company, Worcester, Mass., Oakite Products Company, New York, Palmer Bee Co., Detroit, Permutit Company, New York, Reeves Pulley Company of New York, Inc., New York, Republic Flow Meters Company, Chicago, The Sharples Specialty Company, Philadelphia, Spencer Turbine Company, Hartford, Taylor Instrument Company, Rochester, Time-O-Stat Controls Company, Elkhart.

Changes in Board—Libbey-Owens-Ford

A few days before the annual stockholders' meeting of the Libbey-Owens-Ford Glass Company was held at Toledo on December 3 an announcement was made that the resignation of James C. Blair, chairman of the board and B. C. Root, executive vice-president had been accepted. Mr. Blair continues as the director of the company but Mr. Root resigned both his vice-presidency and directorship. Intense interest was manifested by the trade in this announcement.

The annual report showed net manufacturing profit for the year ended September 30 of $3,177,103 and other income including profit on sale of securities brought the total income to $3,714,935. General, selling and administrative expense was $1,925,632 and provisions for contingencies and taxes brought the net profit down to $1,419,303. The profit and loss surplus account through the acquisition of the net assets of the Edward Ford Plate Glass Company was increased from about ten million dollars a year ago to $23,386,104.

It was also stated by John D. Biggers, re-elected president of the Libbey-Owens-Ford Glass Company, that the responsibilities of David H. Goodwillie, vice-president in charge of engineering since the Libbey-Owens-Ford merger, had been increased and he had been made vice-president in charge of both engineering and production.

Mr. Goodwillie, it was said, was largely responsible for the development of the Bicheroux process in the Edward Ford Plate Glass Company before it joined the Libbey-Owens interests.

It was also reported that Edwin Ashcroft, attorney for the Graham Brothers Company and J. Donald Duncan have been elected directors of the Libbey-Owens-Ford Glass Company.

Movie Film on Refractories Available

Laclede-Christy Clay Products Company, manufacturers of glass house refractories, announce that a film produced in 1923 under the direction of the U. S. Bureau of Mines in cooperation with the Laclede organization and which was one of the first of its kind in the refractory industry, has recently been revised to include improvements that have taken place, such as the modern methods of burning refractories by tunnel kilns and the use of improved equipment and machinery. Three such reels were recently shown before the Student Branch of the American Ceramic Society at the New York State School of Ceramics, Alfred, N. Y. They deal with the manufacture and application of fire clay products and do so in an interesting and realistic manner that can be appreciated readily by the specialist or the layman.

It requires about 45 minutes to project. It is available in the 35 mm. and 16 mm. sizes, for stationary or portable projectors. Copies are distributed by the U. S. Department of Commerce, Bureau of Mines, Pittsburgh, Pa., under the motion picture subject No. 97 story of "Fire Clay Refractories." There is no rental charge.

Tell The World More About Glass

F. C. Flint, general chairman of the Membership Committee of the American Ceramic Society, is circulating an appeal designed to obtain greater cooperation from glass and ceramic manufacturers than heretofore and from individuals connected with these industries who are not as yet members of the Society in order to build up its effectiveness and influence through an enlarged membership both of corporations and persons.

Mr. Flint emphasizes the urgent necessity for the close and continuous cooperation of the entire ceramic industry in helping to solve the problems of the industry and meeting the competition of products from outside of the ceramic field. "We must gain greater power and momentum in ceramic research and education if we are to keep our industries equipped to meet the competition of non-ceramic products." Every concern in the industry and each person connected with it can aid in accomplishing these objects by becoming a member of the Society.

New British Bottle-Making Machine

A new glass-making machine for turning out airtight containers has just been perfected at the Albion Works, Leeds, and has been placed in operation in Lancashire. It is calculated that this machine can turn out 150 bottles per minute. It works automatically in conjunction with the glass furnace.

The machine has eight blowing heads revolving round a central column, and as each head comes under the furnace molten glass is poured into a container. The latter then meets a neck mold, into which the glass is forced. While the neck remains suspended in the mold another final mold closes on it, giving it the desired shape of bottle or jar by the action of compressed air.

German Amsler-Morton Co. Organized

We are informed by Dr. Fritz Eckert, prominent glass technologist of Berlin and well known in America through a visit here in the not distant past, that a European Amsler-Morton Company was formally organized on May 21, 1930, under the name Amsler-Morton Co., G.M.B.H., Berlin, Lichterfeld. The owners of the company are N. A. Morton, P. C. Geer, A Propfe & Co., O. Tangermann and Dr. Fritz Eckert. The organization has been doing business for months past and has advised of receiving orders and of meeting with considerable success. They have constructed furnaces and lehrs, especially in France, Germany, Sweden, England and Roumania as well as in some other countries, in spite of the general prevailing depression in business all over the world.

R. & H. Engages Playhouse for Safety Show

"Accidents in plants do not simply happen. They are generally the result of one of two causes: either unsafe conditions in the plant or a careless attitude of the employees," said L. M. White, assistant superintendent of the R. & H. Chemical Co., in addressing employees and their families at the Safety Show. The show, held in the specially-chartered Capitol Theatre, Niagara Falls, N. Y., December 16, 17 and 18, was featured by a special safety program. Motion pictures were shown and awards made of silver cups and certificates to winning departments.

The playhouse, having a capacity of 1,200, was packed at all the programs. The interest in the subject matter of the safety pictures and program was demonstrated by the extreme quiet during the presentation.

Comedies, news reels and other short pictures were interposed between the safety movies. Further emphasis on safety was given by Doc Volkman, in charge of First Aid at the plant, who spoke

briefly on the application of first aid in usual-run accidents. This was followed by a practical demonstration by Mr. Volkman, assistants and members of one of the R. & H. first aid teams.

Silver cups were presented to A. Lane, F. Mitchell, J. A. Wilson and J. Whitaker, on behalf of the excellent safety records of their respective departments. Each cup was suitably inscribed with a reminder of the fine records made during the past year. Safety certificates were awarded several departments.

The third night was featured by the presentation of 25-year service awards by Dr. H. R. Carveth. Dr. Carveth made a short address felicitating M. Murphy, S. A. Adams and Charles Pirie, and presented them with handsome watches suitably inscribed as a token of esteem.

The entire theatre program was arranged and supervised by John Faill, chemist, L. F. Auman, labor superintendent, and Arthur Volkman.

Cheap Incandescent Lamps

Large consignments of electric bulbs sold in Woolworth's three-penny and sixpenny department store at 12c each have stirred up considerable comment abroad. It was reported that 12,000,000 cheap bulbs for this purpose had been ordered from the Siemens-Halske Company's factory near Leningrad, Russia. The annual output of electric lamps is said to have reached 36,000,000 lamps during the past year and it is estimated that during this year production would amount to 66,000,000 lamps.

Increase Duty on Advertising Matter

Advertising matter mailed to Canada will be assessed an increased duty at the rate of 15c per pound or 35% *ad valorem*, whichever is higher. The announcement mentions certain restrictions in the application of this duty and lists a scale of duty payable on packages from 2¼ oz. up to 12 oz. in weight.

Piping Natural Gas to Washington

A 20-inch gas pipe line between Southern Pennsylvania and Washington, D. C., is nearing completion. This is the first step is an elaborate plan being completed for bringing natural gas from Kentucky and West Virginia to the Eastern Seaboard.

The Austin Company, architects, engineers and builders, 16112 Euclid Avenue, Cleveland, O., recently established at Toronto a second office in Canada, the first one at Vancouver, B. C., having been in operation for several years. It is expected that with the additional facilities for serving the eastern Canadian field, a substantial increase in the development of their activities will take place.

The National Glass Distributors at their December meeting in Pittsburgh elected Clarence W. Condie of St. Louis, as president, succeeding S. C. Gilmore, Philadelphia; Powers Pace of Atlanta, first vice-president; Morris Tyre of San Francisco, second vice-president; and North Storms of Chicago was re-elected secretary and treaturer, an office which he has held for the past ten years.

The Western Plate Glass Company, Richfield, Utah, has been made the beneficiary of a resolution passed by the city council whereby the city agrees to donate a 100-acre site for a proposed glass factory, also a site for a hospital to serve the whole county, and a right of way for a spur track from the D. & R. G. Railroad.

Wm. J. Miller, Inc., designers and builders of glassmaking machinery and equipment, advise that after forwarding copies of their 1931 illustrated calendar to all domestic and foreign glass manufacturers they still have a few of them left and will be glad to forward one to any glass concern upon application, so long as they last.

Monaca Glass Company has made application for a Pennsylvania charter, permitting them to manufacture and deal in glass bottles and other containers. C. R. Underwood, G. A. Mengle, C. C. Huston, Finley B. Hess and Robert A. McKabe, Jr., are interested.

Hammill & Gillespie, Inc., New York, importers and grinders of white minerals and earth colors, announce a new Manhattan warehouse service at Brooklyn Bridge Arch 14, Frankfort Street, New York.

The Santa Anna Glass Co., Santa Anna, Texas, according to press reports is making plans to establish a glass manufacturing plant in that city.

"Who's Who in America" states, according to a review by the *United Press* of a new edition, that there are 324 Pittsburghers listed in the volume, among which there appears to be only one glass man, Harry S. Wherrett, President of the Pittsburgh Plate Glass Company.

Recent Deaths

Halbert Kellogg Hitchcock

Halbert Kellogg Hitchcock, consulting engineer for the Pittsburgh Plate Glass Company and an inventor of note died at his home in Pittsburgh on Monday night, November 24. He had been with that company since 1901. He was a member of social and fraternal organizations and of many scientific societies.

George T. Fulton

George T. Fulton, president for years of the Fulton Glass Company of Marion, Ind., and a very well known resident of that city, died on December 1, 1930.

Coming Meetings

American Ceramic Congress and Exposition, February 23-27 inclusive, 1931, at the Cleveland Public Auditorium, Cleveland, Ohio. Ross C. Purdy, 2525 N. High Street, Columbus, Ohio.

Western Glass and Pottery Association, Fort Pitt Hotel, Pittsburgh, Pa., January, 1931. F. A. H. Lang, secretary, Cambridge Springs, Pa.

The Pittsburgh Glass and Pottery Show takes place in Pittsburgh Jan. 12-24.

Inquiries Received

For further information address THE GLASS INDUSTRY.

532. Please furnish us with names of reliable manufacturers of polariscopes.
533. Kindly advise us if you know of anybody manufacturing stencils for sandblasting door lights as we would like to purchase a few for decorating some of our window glass.
534. We would be interested to learn who furnishes bulb edge tumblers as described in the article by Roy E. Swain in the June, 1930, issue.
535. Can you refer us to the manufacturer of a bulb making machine capable of turning out ultraviolet bulbs from 100 to 500 watt capacity in quantities ranging from 10,000 to 20,000 per day.

What the World Wants

Specific Inquiries for American Goods Received in the Department of Commerce, Washington, D. C. For further information write the department

Canada—48812, Glassware, colored and crystal, plain and decorated, cheaper grades.

Canada—48929, Glassware, office, such as sponge cups, ash trays, and moisteners.

Canada—49074, Glass beads, balls, pendants, etc., colored and plain, for use in decorating light fixtures.

San Juan, P. R.—49227, Glass, window and door, frosted, wired and non-shattering.

Readers Wants and Offers

Address answers to all "keyed" ads c/o The GLASS INDUSTRY 24 West 40th St., New York

EXPERIENCED GLASS MAN

Wanted: Experienced glass maker to take charge of modern plant equipped with continuous furnaces using natural gas. Successful applicant must be capable and have record of continuous successful experience elsewhere. Term contract if desired. Excellent opportunity for advancement with young concern. **All Replies Kept Strictly Confidential Being Seen Only by President of Company and Returned if Unsuccessful.** State age, education and experience first letter. Address "Classified J1."

Current Prices of Glass-Making Materials

December 19, 1930

Quotations furnished by various producers, manufacturers and dealers.

		Carlots	Less Carlots
Acid			
Citric (dom.)	lb.	.40	40
Hydrochloric (HCl) 20° tanks, per 100 lb		..	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	..	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.	lb.	5.50	..
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	..
Tartaric	lb.	..	.33½
Alcohol, denatured	gal.	..	.52
Aluminum hydrate ($Al(OH)_3$)	lb.	.04½-.05	.05½-.06
Aluminum oxide (Al_2O_3)	lb.	..	.07
Ammonium bifluoride (NH_4) FHF	lb.	..	.19
Ammonia water (NH_4OH) 26° drums	lb.	.03	.03¼
Antimony, metallic (Sb)	lb.	..	.09¾
Antimony oxide (Sb_2O_3)	lb.	..	.09¾
Antimony sulphide (Sb_2S_3)	lb.	..	.14
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.04	.04½
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	47.00	..
90% through 100 mesh	ton	44.00	..
Barium hydrate ($Ba(OH)_2$)	lb.	..	.05-.05½
Barium mixture, glassmaker's, f.o.b. St. Louis	ton	25.00	..
Barium nitrate ($Ba(NO_3)_2$)	lb.	.08	.08¼
Barium selenite ($BaSeO_3$)	lb.	..	..
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk, f.o.b. shipping point	ton	15.00-16.00	18.00
Bone ash	carlots, lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	..	.0355-.0425
Crystal	lb.	.028-.033	..
Granulated	lb.	.025-.03	..
Powdered	lb.	.02875-.03375	..
Boric acid (H_3BO_3)	lb.	.0625-.07125	.06-.08125
Refined	lb	.0625-.07125	.07125-.08125
Cadmium sulphide (CdS)—			
Red	lb.	..	.70-.90
Orange	lb.	..	.70-.90
Yellow	lb.	..	1.30-1.50
Chromium oxide (Cr_2O_3)	lb.	.24	.26
Cobalt oxide (Co_2O_3)			
In bbls.	lb.	..	1.90
In 10 lb. tins	lb.	..	2.00-2.20
Copper oxide			
Red (Cu_2O)	lb.	..	.25
Black (CuO)	lb.	..	.18-.25
Black prepared	lb	..	.22
Cryolite ($Na_3Al\ F_6$) Natural Greenland Kryolith)	lb.	.09	.10-.10½
Synthetic (Artificial)	lb.	..	.09½
Epsom salts ($MgSO_4$) (imported) Per 100 lb.		..	1.15-1.20
Feldspar—			
100 mesh	ton	12.50-20.00	13.50-22.00
80 mesh	ton	11.00-11.75	14.50
40 mesh	ton	11.00	13.50
20 mesh	ton	10.00	10.50
Fluorspar (CaF_2) domestic, ground, 95-98% (max SiO_2 2½%)			
Bulk, carloads, f.o.b. mines	ton	32.50	..
In bags or barrels	ton	36.50	41.50
Imported	ton	36.50	38.50-40.00
Formaldehyde	lb	..	.07½-.07¾
Graphite (C)	lb	..	.04-.07
Iron oxide—			
Red (Fe_2O_3)	lb	..	.0450
Black (FeO)	lb	.04½	..
Kaolin (f.o.b mine)	ton	8.00-9.00	..
English, lump, f.o.b. New York	ton	14.50-25.00	24.50-30.00
Kryolith (see Cryolite)		Carlots	Less Carlots
Lead chromate ($PbCrO_4$)	lb.	..	30
Lead oxide (Pb_3O_4) (red lead)	lb	.760-.09¼	.08¾-.09¼
Litharge (PbO)	lb.	.660-.08¼	.07¾-.08¼
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	7.75	..
Burnt (CaO) ground, in bulk	ton	6.00	..
Burnt, ground, in paper sacks	ton	8.00	..
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.15	2.30
Limestone ($CaCO_3$)		1.75-2.50	..
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb.	.06	.07
light (in bbls.)	lb.	..	.23
extra light (in bbls.)	lb.	..	.37
Magnesium carbonate ($MgCO_3$)	lb.	.06	.07-.10½
Manganese 85% (MnO_2)	lb.	.03	.03
Nickel oxide (Ni_2O_3), black— for nickel content	lb.	..	.35
Nickel monoxide (NiO), green— for nickel content	lb.	..	.35
Plaster of Paris, bags	ton	21.00	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.09	.09¼
Ground	lb.	.11	.12
Potassium carbonate—94-96%	lb.	.0555	.0555
Calcined (K_2CO_3) 96-98%	lb.	.06½	.07¼
Hydrated 80-85%	lb.	.05¾	.06¼
Potassium chromate (K_2CrO_4)	lb.	..	.23-.32
Potassium hydrate (KOH) (caustic potash)	lb.	.07¼	.08
Potassium nitrate (KNO_3) (gran.)	lb.	..	.06½-.06¾
Potassium permanganate ($KMnO_4$)	lb.	.16	.17
Powdered blue	lb.	..	.24-.26
Rochelle salts, bbls.	lb.	..	.19
Rouge	lb.	..	..
Rutile (TiO_2) powdered, 95%	lb.	.15-.20	.20-.25
Salt cake, glassmakers (Na_2SO_4)	ton	22.00	..
Selenium (Se)	lb.	..	1.80-1.90
Silver nitrate ($AgNO_3$)	(100 oz.) per oz.	..	.26¼
Soda ash (Na_2CO_3) dense, 58%—			
Bulk, on contract	Flat per 100 lb.	1.22½	..
In barrels	Per 100 lb.	1.55-1.57½	1.90-2.00
In bags	Per 100 lb.	1.37½-1.40	1.72½
Spot orders. .025 per 100 lbs. higher		..	..
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.07	.07½
Sodium hydrate (NaOH) (caustic soda) Solid	Per 100 lb.	2.95	..
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	.03¾	.04¼
95 per cent.	Per 100 lb.	1.96½-2.10	2.15-2.25
Sodium selenite (Na_2SeO_3)	lb.	..	2.00
Sodium fluosilicate (Na_2SiF_6)	lb.	.05	.05½
Sodium uranate (Na_2UO_4) Yellow or Orange	lb.	..	1.50-1.55
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.45	3.80-4.00
Flowers, in bags	Per 100 lb.	3.10	3.45-3.65
Flour, heavy in bbls.	Per 100 lb.	2.85	3.20-3.40
Tin chloride ($SnCl_2$) (crystals)	lb.	.37½	.39
Tin oxide (SnO_2) in bbls.	lb.	..	.33-.37
Uranium oxide (UO_2) (black, 96% U_3O_8)			
100 lb. lots. Black	lb.	..	2.75
Yellow	lb.	..	1.50
Zinc oxide (ZnO)	lb.	.08¼	.12
American process, Bags	lb.	.06½	.07
Zircon			
Granular (Milled .005-.02c higher)		.07	.07½-.08
Crude. Gran. (Milled .005-.02c higher)		03¼	.04-.05

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to November 24, 1930

	October 1929 Quantity	October 1929 Value	October 1930 Quantity	October 1930 Value	Ten Months Ending October 1929 Quantity	Ten Months Ending October 1929 Value	Ten Months Ending October 1930 Quantity	Ten Months Ending October 1930 Value
Glass and glass products (Total)	.....	1,019,163	.....	780,137	.....	9,204,406	.....	7,723,163
Plate and window glass—								
Window glass, common, box 50 sq. ft.	1,247	7,558	263	1,404	14,630	85,659	14,347	78,258
Plate glass, unsilvered, sq. ft.	140,475	51,843	275,201	90,461	1,644,380	593,813	2,868,197	891,416
Other window and plate glass lbs.	530,776	43,653	517,734	42,721	3,916,742	413,027	4,616,639	392,993
Glass containers (bottles, vials and jars)	.....	322,617	.....	209,676	.....	3,084,821	.....	2,590,046
Table glassware, plain	.....	150,802	.....	128,510	.....	1,249,898	.....	916,601
Table and other glassware, cut or engraved	.....	12,536	.....	8,977	.....	101,525	.....	80,394
Lamp chimneys and lantern globes lbs.	128,892	25,886	78,388	13,751	1,400,497	282,000	1,028,724	190,686
Globes and shades for lighting fixtures lbs.	227,794	76,851	114,973	48,020	1,757,040	633,389	1,366,153	501,704
Chemical glassware lbs.	28,982	28,221	39,513	23,649	232,524	203,822	228,016	198,464
Electrical glassware, except for lighting lbs.	298,093	37,681	281,402	22,941	4,470,137	368,986	3,297,512	224,924
Other glassware	.....	261,515	.....	190,027	.....	2,187,466	.....	1,657,677

IMPORTS

Corrected to November 24, 1930

Glass and glass products	.....	1,317,357	.....	809,608	.....	12,059,715	.....	7,698,579
Cylinder, crown and sheet—								
Plain	dut. lb.	3,988,131	144,744	859,814	33,884	61,174,666	1,962,215	13,640,376	531,893
Bent, beveled, colored, etc.	dut. lb.	.....	48,619	238,891	23,624	.....	480,362	1,053,164	301,730
Made into mirrors	dut. sq. ft.	.....	.....	24	183	.....	.....	[2]401	[2]886
Plate glass—								
Plain	dut. sq. ft.	941,694	199,162	457,145	81,025	9,094,120	1,898,005	4,182,583	833,158
Bent, beveled, colored, etc., and mirrors	dut. sq. ft.	182,828	39,683	24,812	15,770	1,198,467	256,955	553,190	174,749
Rolled cylinder, crown, and sheet glass, ground, obscured, bent, beveled, colored, etc.	dut. sq. ft.	.....	.....	.....	4,995	.....	.....	(2)	[2]18,749
Laminated and plated glass	dut.	.....	.....	.....	1,716	.....	.....	.....	[2]12,396
Bottles, vials, jars, and other containers	dut.	.....	27,298	.....	79,931	.....	215,873	.....	993,600
Scientific articles and utensils	dut.	.....	68,052	.....	38,377	.....	557,488	.....	448,462
Tubes and rods	dut.	.....	.....	.....	8,872	.....	.....	.....	[2]31,545
Illuminating articles	dut.	.....	63,620	.....	54,983	.....	700,680	.....	511,493
Blown glass articles	dut.	.....	547,050	.....	344,444	.....	4,470,236	.....	2,726,788
Pressed glass articles	dut.	.....	22,784	.....	20,605	.....	251,429	.....	178,555
Other glassware	dut.	.....	156,345	.....	101,199	.....	1,266,472	.....	934,575

[2] Beginning June 18, 1930.